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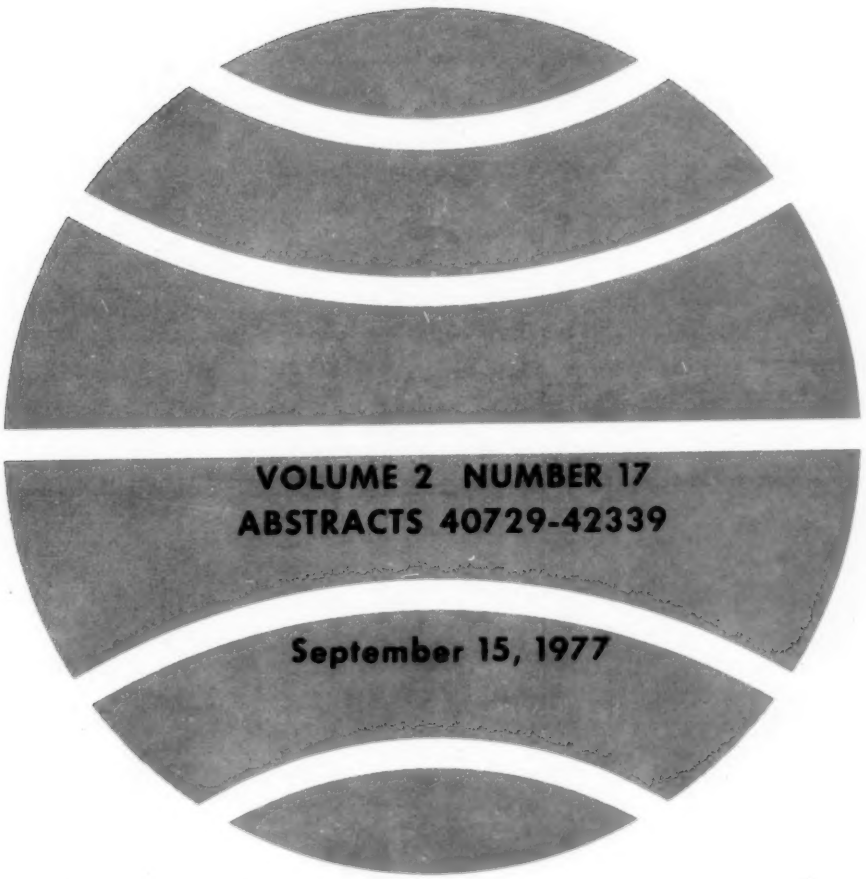

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CONTENTS

Category	Page
COAL AND COAL PRODUCTS	4207
PROCESSING	4207
CARBONIZATION	4207
DESULFURIZATION AND PURIFICATION	4208
HYDROGENATION	4209
GASIFICATION	4209
LIQUEFACTION	4216
PYROLYSIS AND CRACKING	4216
SOLVENT EXTRACTION	4217
BY-PRODUCTS	4217
PROPERTIES	4218
WASTE MANAGEMENT	4222
ENVIRONMENTAL ASPECTS	4222
RESERVES AND EXPLORATION	4223
MINING	4223
TRANSPORT AND HANDLING	4225
COMBUSTION	4226
MARKETING AND ECONOMICS	4227
HEALTH AND SAFETY	4227
PETROLEUM	4227
RESERVES	4227
GEOLOGY AND EXPLORATION	4227
DRILLING AND PRODUCTION	4228
PROCESSING	4229
PRODUCTS AND BY-PRODUCTS	4231
MARKETING AND ECONOMICS	4232
WASTE MANAGEMENT	4233
ENVIRONMENTAL ASPECTS	4233
POLICY, LEGISLATION, AND REGULATION	4235
TRANSPORT, PIPELINES, AND HANDLING	4235
PROPERTIES	4235
STORAGE	4238
COMBUSTION	4238
NATURAL GAS	4239
RESERVES	4239
GEOLOGY AND EXPLORATION	4239
DRILLING, PRODUCTION, AND PROCESSING	4239
MARKETING AND ECONOMICS	4239
ARTIFICIAL STIMULATION, PLOWSHARE, ETC.	4239
TRANSPORT, PIPELINES, AND HANDLING	4239
STORAGE	4240
OIL SHALES AND TAR SANDS	4240
OIL PRODUCTION, RECOVERY, AND REFINING	4240
IN SITU METHODS, TRUE AND MODIFIED	4240
SURFACE METHODS	4240
REFINING	4241
PURIFICATION	4241
PROPERTIES AND COMPOSITION	4242
DIRECT USES AND BY-PRODUCTS	4242
WASTE RESEARCH AND MANAGEMENT	4242
FISSION FUELS	4243
RESERVES	4243
EXPLORATION	4243
MINING	4243
FEED PROCESSING	4243
ENRICHMENT	4243
FUELS PRODUCTION AND PROPERTIES	4244
SPENT FUELS REPROCESSING	4245
TRANSPORT AND STORAGE	4246
MARKETING AND ECONOMICS	4247
WASTE MANAGEMENT	4248
WASTE PROCESSING	4251
WASTE DISPOSAL AND STORAGE	4251
ENVIRONMENTAL ASPECTS	4253
HEALTH AND SAFETY	4253
REGULATIONS	4253
ACCOUNTABILITY AND SAFEGUARDS	4253

Category	Page
FUSION FUELS	4253
PROCESSING	4253
ISOTOPE AND RADIATION SOURCE TECHNOLOGY	4254
PHYSICAL ISOTOPE SEPARATION	4254
RADIATION SOURCES	4254
DESIGN AND FABRICATION	4254
ISOTOPIC POWER SUPPLIES	4254
DESIGN AND FABRICATION	4254
HYDROGEN	4254
PRODUCTION	4255
ELECTROLYSIS	4255
THERMOCHEMICAL PROCESSES	4255
COAL GASIFICATION	4255
STORAGE	4255
CHEMISORPTION	4255
TRANSPORT	4255
INDUSTRIAL AND COMMERCIAL USE	4255
PROPERTIES	4255
OTHER SYNTHETIC AND NATURAL FUELS	4255
PROPERTIES	4255
PREPARATION	4256
CHEMICAL SYNTHESIS	4256
PREPARATION FROM WASTES OR BIOMASS	4256
PROPERTIES	4256
CHEMICAL SYNTHESIS	4256
PREPARATION	4256
SOLID WASTE FUELS	4256
HYDRO ENERGY	4257
RESOURCES AND AVAILABILITY	4257
PLANT DESIGN AND OPERATION	4257
SOLAR ENERGY	4257
RESOURCES AND AVAILABILITY	4257
ENVIRONMENTAL ASPECTS	4257
SOLAR ENERGY CONVERSION	4257
PHOTOVOLTAIC CONVERSION	4257
THERMIONIC CONVERSION	4259
PHOTOSYNTHETIC CONVERSION	4259
PHOTOVOLTAIC POWER PLANTS	4259
SOLAR THERMAL POWER PLANTS	4259
TOWER FOCUS POWER PLANTS	4260
SOLAR RADIATION UTILIZATION	4260
SPACE HEATING AND AIR CONDITIONING	4260
DRYING AND CURING	4262
HEAT ENGINES	4262
SOLAR COLLECTORS AND CONCENTRATORS	4262
HEAT STORAGE AND REJECTION	4262
GEOTHERMAL ENERGY	4263
GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY	4263
GEOPHYSICAL TECHNIQUES AND SURVEYS	4263
EXPLORATORY DRILLING AND WELL LOGGING	4263
ECONOMIC AND FINANCIAL ASPECTS	4263
ENVIRONMENTAL ASPECTS AND WASTE DISPOSAL	4263
GEOTHERMAL POWER PLANTS	4263
POWER PLANT SYSTEMS AND COMPONENTS	4263
GEOTHERMAL ENGINEERING	4263
DRILLING TECHNOLOGY AND WELL HARDWARE	4263
CORROSION, SCALING, AND MATERIALS DEVELOPMENT	4263
DIRECT ENERGY UTILIZATION	4263
GEOTHERMAL DATA AND THEORY	4263
PROPERTIES OF AQUEOUS SOLUTIONS	4263

CONTENTS (continued)

Category	Page
GEOTHERMAL ENERGY—Continued	
PROPERTIES OF MINERALS AND ROCKS	4264
ROCK-WATER-GAS INTERACTIONS	4264
TIDAL POWER	4264
WAVE ENERGY CONVERTERS	4264
WIND ENERGY	4264
AVAILABILITY (CLIMATOLOGY)	4264
WIND ENERGY ENGINEERING	4264
POWER CONVERSION SYSTEMS	4264
SITE CHARACTERISTICS	4264
ELECTRIC POWER ENGINEERING	4264
POWER PLANTS AND POWER GENERATION	4264
COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS	4265
POWER CYCLES	4265
WASTE-FUELED SYSTEMS	4265
COMPONENTS	4266
WASTE HEAT UTILIZATION	4266
ECONOMICS	4266
FUELS	4267
ENVIRONMENTAL ASPECTS	4267
THERMAL EFFLUENTS	4267
NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL	4267
SITE SELECTION AND LAND USE	4267
POWER TRANSMISSION AND DISTRIBUTION	4268
AC SYSTEMS, EHV AND UHV	4268
DC SYSTEMS	4268
SUPERCONDUCTING AND CRYOGENIC SYSTEMS	4269
NUCLEAR POWER PLANTS	4269
POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED	4271
POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED	4273
POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED	4275
POWER REACTORS, NON-BREEDING, OTHERWISE MODERATED OR UNMODERATED	4277
POWER REACTORS, BREEDING	4279
POWER REACTORS, AUXILIARY, MOBILE, PACKAGE, AND TRANSPORTABLE	4285
REGULATION AND LICENSING	4285
ECONOMICS	4286
FUEL CYCLE	4286
PROCESS HEAT REACTORS	4287
NUCLEAR REACTOR TECHNOLOGY	4288
THEORY AND CALCULATION	4288
COMPONENTS AND ACCESSORIES	4289
FUEL ELEMENTS	4291
CONTROL SYSTEMS	4291
ENVIRONMENTAL ASPECTS	4292
SITING	4292
RADIOACTIVE EFFLUENTS	4292
CHEMICAL AND THERMAL EFFLUENTS	4292
RESEARCH, TEST, AND EXPERIMENTAL REACTORS	4292
PLUTONIUM AND ISOTOPE PRODUCTION REACTORS	4293
PROPULSION REACTORS	4293
REACTOR SAFETY	4293
ENERGY STORAGE	4300
MAGNETIC	4300
PUMPED HYDRO	4300
FLYWHEELS	4300
THERMAL	4300
BATTERIES	4301
DESIGN AND DEVELOPMENT	4301
PERFORMANCE AND TESTING	4301
MATERIALS, COMPONENTS, AND AUXILIARIES	4301
ENERGY MANAGEMENT AND POLICY	4302
SYSTEMS STUDIES AND TOTAL ENERGY	4302
ECONOMICS AND SOCIOLOGY	4303
ENVIRONMENT, HEALTH, AND SAFETY	4303
ENERGY RESOURCES	4305
RESEARCH AND DEVELOPMENT	4305
NUCLEAR ENERGY	4305
CONSERVATION	4305
SUPPLY, DEMAND, AND FORECASTING	4308
POLICY, LEGISLATION, AND REGULATION	4308
FOSSIL FUELS	4309
COAL	4309
PETROLEUM	4309
NATURAL GAS	4310
HYDROGEN AND SYNTHETIC FUELS	4310
ELECTRIC POWER	4310
ELECTRIC POWER GENERATION	4310
CONSUMPTION AND UTILIZATION	4311
UNCONVENTIONAL SOURCES AND POWER GENERATION	4311
SOLAR	4311
OTHER	4311
ENERGY CONVERSION	4311
MHD GENERATORS	4311
DESIGN AND DEVELOPMENT	4311
MATERIALS, COMPONENTS, AND AUXILIARIES	4312
DUCT ENGINEERING AND FLUID DYNAMICS	4312
THERMOELECTRIC GENERATORS	4312
THERMIONIC CONVERTERS	4312
DESIGN AND DEVELOPMENT	4312
FUEL CELLS	4312
PERFORMANCE AND TESTING	4312
MATERIALS, COMPONENTS, AND AUXILIARIES	4312
BRAYTON	4312
ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION	4312
BUILDINGS	4312
RESIDENTIAL	4313
OFFICE	4313
SCHOOL	4313
COMMERCIAL	4313
TRANSPORTATION AND PROPULSION	4313
AIR AND AEROSPACE	4314
LAND AND ROADWAY	4314
INDUSTRY	4315
ENERGY SOURCES	4315
EQUIPMENT AND PROCESSES	4315
WASTE HEAT UTILIZATION	4315
RECYCLING	4315
WASTE MANAGEMENT	4315
ADVANCED AUTOMOTIVE PROPULSION SYSTEMS	4316
INTERNAL COMBUSTION ENGINES	4317
SPARK-IGNITION	4317
DIESEL	4318
TURBINE	4318
ROTARY	4318
EXTERNAL COMBUSTION ENGINES	4318
STIRLING CYCLE	4318
RANKINE CYCLE	4318
ELECTRIC-POWERED SYSTEMS	4319
HYBRID SYSTEMS	4319
VEHICLE DESIGN FACTORS	4319
BODY AND CHASSIS	4320
ENGINE-TRANSMISSION MATCHING	4320
ENGINE SYSTEM	4320
EMISSION CONTROL	4320
NITROGEN OXIDES	4321
CARBON MONOXIDE	4321
HYDROCARBONS	4321
ALTERNATIVE FUELS	4321
MATERIALS	4321

CONTENTS (continued)

Category	Page
MATERIALS—Continued	
METALS AND ALLOYS	4321
PREPARATION AND FABRICATION	4321
STRUCTURE AND PHASE STUDIES	4322
MECHANICAL PROPERTIES	4325
PHYSICAL PROPERTIES	4326
CORROSION AND EROSION	4328
RADIATION EFFECTS	4329
CERAMICS, CERMETS, AND REFRACTORIES	4329
PREPARATION AND FABRICATION	4329
STRUCTURE AND PHASE STUDIES	4329
MECHANICAL PROPERTIES	4331
PHYSICAL PROPERTIES	4331
RADIATION EFFECTS	4333
COMPOSITE MATERIALS	4333
MECHANICAL PROPERTIES	4333
PHYSICAL PROPERTIES	4334
OTHER MATERIALS	4334
PREPARATION AND MANUFACTURE	4334
STRUCTURE AND PHASE STUDIES	4334
PROPERTIES	4334
RADIATION EFFECTS	4334
CHEMISTRY	4334
ANALYTICAL AND SEPARATIONS CHEMISTRY	4334
ACTIVATION AND NUCLEAR REACTION PROCEDURES	4334
CHEMICAL PROCEDURES	4335
RADIOMETRIC AND RADIOCHEMICAL PROCEDURES	4335
SPECTRAL PROCEDURES	4335
SEPARATION PROCEDURES	4335
INORGANIC AND PHYSICAL CHEMISTRY	4335
CHEMICAL AND PHYSICOCHEMICAL PROPERTIES	4335
ORGANIC CHEMISTRY	4335
CHEMICAL AND PHYSICOCHEMICAL PROPERTIES	4335
ELECTROCHEMISTRY	4336
RADIATION CHEMISTRY	4336
PROPERTIES OF RADIOACTIVE MATERIALS	4336
COMBUSTION CHEMISTRY	4336
ENGINEERING	4336
GENERAL ENGINEERING	4336
FACILITIES AND EQUIPMENT	4336
CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES	4336
PROTECTIVE STRUCTURES AND EQUIPMENT	4337
HANDLING EQUIPMENT AND PROCEDURES	4337
SHIPPING CONTAINERS	4337
MINING AND DRILLING EQUIPMENT AND FACILITIES	4337
LASERS	4337
HEAT TRANSFER AND FLUID FLOW	4340
SAFETY ENGINEERING	4340
ELECTRONIC CIRCUITS AND DEVICES	4340
SOLID WASTE PROCESSING PLANTS AND EQUIPMENT	4340
COMBUSTION SYSTEMS	4340
UNDERGROUND ENGINEERING	4340
PARTICLE ACCELERATORS	4340
BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS	4340
STORAGE RINGS	4341
INSTRUMENTATION	4341
RADIATION INSTRUMENTATION	4341
GENERAL DETECTORS AND MONITORS	4341
RADIATION DOSEMETERS	4341
HIGH ENERGY PHYSICS INSTRUMENTATION	4341
RADIATION EFFECTS ON INSTRUMENT COMPONENTS, INSTRUMENTS, OR ELECTRONIC SYSTEMS	4341
MISCELLANEOUS INSTRUMENTS	4342
WELL LOGGING INSTRUMENTATION	4342

Category	Page
EXPLOSIONS AND EXPLOSIVES	4342
CHEMICAL	4342
NUCLEAR	4343
CIVIL USES	4343
WEAPONRY	4343
EXPLOSION DETECTION	4343
ENVIRONMENTAL SCIENCES, ATMOSPHERIC	4343
BASIC STUDIES	4343
CHEMICALS MONITORING AND TRANSPORT	4344
RADIOACTIVE MATERIALS MONITORING AND TRANSPORT	4347
THERMAL EFFLUENTS MONITORING AND TRANSPORT	4348
REGULATIONS	4348
ENVIRONMENTAL SCIENCES, TERRESTRIAL	4348
BASIC STUDIES	4348
CHEMICALS MONITORING AND TRANSPORT	4348
RADIOACTIVE MATERIALS MONITORING AND TRANSPORT	4348
TERRESTRIAL ECOSYSTEMS AND FOOD CHAINS	4349
SITE RESOURCE AND USE STUDIES	4349
REGULATIONS	4349
ENVIRONMENTAL SCIENCES, AQUATIC	4349
BASIC STUDIES	4349
RADIOMETRIC TECHNIQUES	4350
CHEMICALS MONITORING AND TRANSPORT	4350
RADIOACTIVE MATERIALS MONITORING AND TRANSPORT	4351
THERMAL EFFLUENTS MONITORING AND TRANSPORT	4351
SITE RESOURCE AND USE STUDIES	4351
REGULATIONS	4351
ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES	4351
SOCIAL AND ECONOMIC STUDIES	4351
ASSESSMENT OF ENERGY TECHNOLOGIES	4351
ENVIRONMENTAL IMPACT STATEMENTS	4351
BIOMEDICAL SCIENCES, BASIC STUDIES	4351
BIOCHEMISTRY	4351
CYTOLOGY	4353
GENETICS	4354
METABOLISM	4355
MEDICINE	4356
TRACER TECHNIQUES	4356
MICROBIOLOGY	4356
PHYSIOLOGICAL SYSTEMS	4356
PUBLIC HEALTH	4357
BIOMEDICAL SCIENCES, APPLIED STUDIES	4357
RADIATION EFFECTS	4357
RADIATION EFFECTS ON CELLS	4357
EXTERNAL SOURCE	4357
RADIATION EFFECTS ON MICROORGANISMS	4358
BASIC STUDIES	4358
FOOD PRESERVATION	4358
RADIATION EFFECTS ON ANIMALS	4358
MAN	4358
VERTEBRATES	4358
RADIONUCLIDE EFFECTS - INTERNAL SOURCE	4359
MAN	4359
ANIMALS	4359
NUCLIDE KINETICS AND TOXICOLOGY	4359
MAN	4359
ANIMALS	4362
THERMAL EFFECTS	4362
VERTEBRATES	4362
CHEMICALS METABOLISM AND TOXICITY	4362
CELLS	4363
PLANTS	4363
INVERTEBRATES	4363
VERTEBRATES	4363
MAN	4364

CONTENTS (continued)

Category	Page
BIOMEDICAL SCIENCES, APPLIED STUDIES—Continued	
OTHER ENVIRONMENTAL POLLUTANT EFFECTS	4364
HEALTH AND SAFETY	4364
GEOSCIENCES	4365
GEOLOGY AND HYDROLOGY	4365
GEOPHYSICS	4365
SEISMOLOGY AND TECTONICS	4365
GEOPHYSICAL SURVEY METHODS	4365
GEOCHEMISTRY	4365
OCEANOGRAPHY	4365
PHYSICS RESEARCH	4366
ASTROPHYSICS AND COSMOLOGY	4366
COSMIC RADIATION	4366
STARS	4366
QUASI-STELLAR, RADIO, AND X-RAY SOURCES	4366
SOLAR PHENOMENA	4367
PLANETARY PHENOMENA	4368
ATMOSPHERIC PHYSICS	4368
AURORAL AND IONOSPHERIC PHENOMENA	4368
EFFECTS OF NUCLEAR DETONATIONS	4369
MAGNETOSPHERIC PHENOMENA	4369
ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS	4370
BEAMS AND THEIR REACTIONS	4370
COLLISION PHENOMENA	4370
GENERAL FLUID DYNAMICS	4370
PROPERTIES AND STRUCTURE OF FLUIDS	4370
MAGNETOHYDRODYNAMICS	4370
PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL	4370
ELECTROMAGNETIC INTERACTIONS	4370
NUCLEAR PHYSICS	4371
EXPERIMENTAL TECHNIQUES	4371
NUCLEAR PROPERTIES AND REACTIONS, A=6-19 THEORETICAL	4371
NUCLEAR REACTIONS AND SCATTERING	4371
NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL	4371
NUCLEAR REACTIONS AND SCATTERING	4371
NUCLEAR PROPERTIES AND REACTIONS, A=20-38, EXPERIMENTAL	4371
NUCLEAR REACTIONS AND SCATTERING	4371
NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL	4371
NUCLEAR REACTIONS AND SCATTERING	4371
NUCLEAR PROPERTIES AND REACTIONS, A=59-89, EXPERIMENTAL	4371
MASS, ABUNDANCE, AND BINDING ENERGY	4371
NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL	4371
NUCLEAR REACTIONS AND SCATTERING	4371
NUCLEAR PROPERTIES AND REACTIONS, A=150-189, THEORETICAL	4372
NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL	4372
NUCLEAR REACTIONS AND SCATTERING	4372
SPONTANEOUS AND INDUCED FISSION	4372
NUCLEAR REACTIONS AND SCATTERING	4372
RADIATION AND SHIELDING PHYSICS	4372
RADIATION PHYSICS	4372
NEUTRON INTERACTIONS WITH MATTER	4372
SOLID STATE PHYSICS	4372
SUPERCONDUCTIVITY	4372
GENERAL THEORY	4372
ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA	4372
FUSION ENERGY	4373
PLASMA RESEARCH	4373
PLASMA CONFINEMENT AND HEATING	4373
PLASMA DIAGNOSTICS	4374
PLASMA KINETICS - GENERAL	4374
PLASMA KINETICS - THEORETICAL	4375
PLASMA PRODUCTION	4375
PLASMA INSTABILITIES	4376
PLASMA WAVE PHENOMENA	4376
FUSION POWER PLANTS	4378
PHYSICS AND BLANKET ENGINEERING	4379
MAGNET COILS AND FIELDS	4379
POWER SUPPLIES AND CIRCUITRY	4380
FUEL SYSTEMS	4380
INERTIAL CONFINEMENT SYSTEMS	4381
COMPONENT DEVELOPMENT AND TESTING	4381
GENERAL AND MISCELLANEOUS	4382
MANAGEMENT	4382
MATHEMATICS AND COMPUTERS	4383
INFORMATION HANDLING	4384
CORPORATE INDEX	1
AUTHOR INDEX	17
SUBJECT INDEX	47
REPORT NUMBER INDEX	129

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Volume 2, Number 17, September 15, 1977

ERDA ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

REFER ALSO TO CITATION(S) 41600, 41602

40729 (ORNL—5252) **Coal technology program quarterly progress report for the period ending December 31, 1976.** (Oak Ridge National Lab., Tenn. (USA)). Apr 1977. Contract W-7405-ENG-26. 209p. Dep. NTIS, PC A10/MF A01.

This quarterly report covers the progress made during the period October 1 through December 31 for research and development projects carried out in support of the increased utilization of coal as a source of clean energy. These projects are supported by the ERDA Divisions of Coal Conversion and Utilization, Major Facility Project Management, Materials and Exploratory Research, Physical Research, and Biomedical and Environmental Research, and by the EPA Office of Research and Development through interagency agreement with the ERDA. The report is divided into the following sections: hydrocarbonization research; residue carbonization; engineering support of in-situ gasification; alkali metal vapor tapping cycles; materials and components testing (especially pressure wrench and pipe and nondestructive testing); analysis of processes and programs; chemical research and development; environmental effects and biological effects of by-products, liquid and gaseous wastes, etc. (LTN)

40730 **International Energy Agency: coal research.** *Energy World;* No. 33, 13-14(Dec 1976).

Agreements signed last year by countries participating in the International Energy Agency's coal technology working group set up five major research projects. One is the Grimethorpe fluidized-bed programme; the other four are service projects, mainly to collect and coordinate information available from a wide variety of sources. They are the data bank of world coal reserves and resources; the technical information service; the economic assessment service; and the mining technology clearing house service.

PROCESSING

REFER ALSO TO CITATION(S) 41450

40731 (ORNL/TM—5819) **Coal technology program progress report for January 1977.** (Oak Ridge National Lab., Tenn. (USA)). Mar 1977. Contract W-7405-ENG-26. 54p. Dep. NTIS $4.50.

Block pyrolysis experiments were begun utilizing eastern bituminous coal from the Pricetown, West Virginia area. Results are significantly different from those obtained in past experiments with western subbituminous coals. Studies of liquid mixing in coal-solvent hydrogenation reactors continued as part of the Coal-Solvent-Hydrogen Mixing project. A series of residence-time, liquid hold-up, and pressure drop measurements was completed for air and clean water flowing cocurrently upward through a bed packed with 4-mm-diam glass spheres. The piping and pressure vessel project has experimental work in progress to determine the effects of heat treatment of 2 1/4 Cr—1 Mo plate. A FY 1977 work statement for inspection techniques for wear- and process-resistant coatings was completed. Experimental deposition of Alloy 20 cladding on carbon and low-alloy steels, and testing for cracking and microfissuring is in progress. An eddy current inspection system has been designed and fabricated and will be used for the inspection of the surveillance test tubes previously subjected to a 500-hr exposure in a fluidized bed coal combustor environment. In the gas-fired potassium boiler work, the parametric cycle analysis of the plant and the analysis of the metal vapor turbine designs for the fluidized-bad, coal-fired, alkali-metal-vapor topping cycle project was completed. Engineering studies and technical support continued with work on process modeling, the process research digest, a survey of industrial equipment capabilities, and s study of large air separation plants. An information assessment on landfill storage of coal conversion solid wastes is complete and final editing is underway.

40732 (ORNL/TM—5858) **Coal technology program progress report for February 1977.** (Oak Ridge National Lab., Tenn. (USA)). Apr 1977. Contract W-7405-ENG-26. 45p. Dep. NTIS, PC A03/MF A01.

Two-dimensional pyrolysis studies were continued using Eastern bituminous coal. Unusual char formations (associated with the swelling nature of the material) have been observed, though tar and gas production per gram is not greatly different from that observed with Western subbituminous coals. Materials engineering support activities continued with work on properties of thick sections of steel, development of methods for nondestructive testing of coatings, cladding of low-alloy steels, fireside corrosion in fluidized bed boilers, failure analysis, and publication of a draft report on the use of prestressed concrete pressure vessels. Design and construction work continued in preparation for operation of the gas-fired boiler with potassium. Design studies of a coal-fired, alkali-metal-vapor, power system continued. Engineering studies and technical support continued with work on process modeling, the process research digest, a survey of industrial equipment capabilities, and a study of large air separation plants. Process and program analysis studies continued with work on low Btu gasification, direct combustion, advanced power systems, liquefaction, in-situ gasification, and beneficiation of coal. In the coal-fueled MIUS project, a 1000-hr endurance run of the coal feed system was completed and analysis of corrosion specimens exposed in a fluidized bed combustor was started.

40733 **Coal processing.** New York; MSS Information Corporation (1976). 150p.

Thirteen articles from the book, "Coal Processing," have been entered individually into EDB and ERA. The articles involve methods for the removal of part of the pyrite in the coal by fine grinding, oil agglomeration, flotation, etc.; degree of rejection of various trace elements by the above processes; reactions of coal with excited nitrogen and hydrogen species in electrical discharges; changes in coal and in its impurities during carbonization; and other miscellaneous papers. (LTN)

CARBONIZATION

REFER ALSO TO CITATION(S) 40743, 40812

40734 **Blending design using many kinds of coal and the evaluation system for single coal.** Miyazu, T.; Okuyama, Y.; Suzuki, N.; Fukuyama, T.; Mori, T. Tokyo; Nippon Kokan (1975). 10p.

The significance of Gieseler fluidity and the mean rank of coalification of blends are discussed, and a new evaluation system for coals when many kinds of coal are blended for coke making is suggested. The minimum prerequisites for a coal blend include a maximum fluidity of higher than 200 ddpm and a mean maximum reflectance of vitrinite of higher than 1.20%. The relationship between maximum fluidity and maximum reflectance for the various coals used are plotted on a graph. This graph, an MOF diagram, is useful in forecasting the merit of a single coal for use as part of a future blend. 16 refs.

40735 **Solving the coking coal problem.** Graham, J.P. *Coal Energy Q.;* No. 10, 15-21(1976).

The major problem confronting the producers of metallurgical coke in recent years has been the shortage of good coking coals, and there is overwhelming evidence that the predominant path to the manufacture of steel will follow the conventional blast furnace

route, using coke made in coke ovens as the principal fuel for, say, two decades to come. The industry therefore faces with increasing urgency the effects of a continuing shortage of prime coking coals and of the better high volatile coals; more stringent quality demands as iron is made in larger, faster driving blast furnaces; increasing costs in all areas and a need to minimize the environmental problems associated with coke-making. In this article the Director of the British Carbonization Research Association summarizes the world coking coal situation, and shows how research facilities in the U.K. are contributing to the future technical and economic viability of the conventional process of coke-making.

40736 Formation of anisotropic mesophase from various carbonaceous materials in early stages of carbonization. Sanada, Y.; Furuta, T.; Kimura, H.; Honda, H. pp 117-133 of In Coal processing. New York; MSS Information Corporation (1976).

The low-temperature carbonization of pitches, reduced crudes, synthetic polymers and various ranks of coals has been studied by polarized-light microscopy, X-ray diffraction and solvent extraction. Formation of anisotropic mesophase is a function of heat-treatment temperature and residence time for those materials that pass through a fusion stage in the temperature range from 350 to 500°C. The nucleation of spherules from the pitches and reduced crude during low-temperature carbonization is proportional to the amount of β-resin, which is benzene-insoluble and quinoline-soluble, and the rate of its formation. Addition of sulphur to the pitch turns the texture of mesophase spherules to that of a fine mosaic when the mixtures are heat-treated in the temperature range of 350 to 500°C. Methylation of the hydroxyl groups in 3,5-dimethyl phenol formaldehyde resin, by reacting with dimethyl sulphate, gives an anisotropic texture which consists actually of tiny spherules together with parent matrix; the original resin gives the typical mosaic texture. The molecular forces in the decomposing carbonaceous materials during low-temperature carbonization are among important factors governing the mesophase transformation. A common mechanism of formation of various anisotropic textures can explain the behavior of coal-cokes, pitch, crudes and polymers.

40737 Changes in state of combination of inorganic constituents during carbonization of Victorian brown coal. Murray, J.B. pp 134-148 of In Coal processing. New York; MSS Information Corporation (1976).

The inorganic constituents of low-rank Victorian brown coal, which are mainly present as inherent inorganic combinations attached to the coal molecule, are different from the minerals present in higher-rank coals. Changes in the state of combination of the inorganics in the chars of these coals have been studied by determining the minerals formed when chars are prepared at various temperatures. It is shown that when brown coals containing inorganic carboxylates are carbonized, the reactive functional groups which are present will begin to decompose below 400°C and their decomposition is completed by 600°C. The inorganic elements released will form mineral combinations depending on the carbonizing temperature and the reduction potential of the metal. Sodium carbonate, calcium oxide, magnesium oxide (periclase) and iron oxide (magnetite) are usually the chief minerals that may be formed. Mineral constituents present in the original coal may also change during carbonization. As the temperature increases, hydrated oxides of iron, clay and aluminium will lose water of crystallization and become dehydrated, forming magnetite, dried clay and alumina. Pyrite will lose up to half its sulphur at 400 to 450°C. If the carbonization temperature is over 600°C, metallic iron may be formed from the magnetite, and sodium chloride (and later sodium carbonate) will volatilize. Quartz remains unaltered.

40738 Energy savings by programmed heating of coke ovens. Merrick, D. *Energy World;* No. 34, 7-8(Jan 1977).

Programmed heating has considerable potential for achieving energy savings in coke manufacture. Bergbau—Forschung has developed such a system and is carrying out tests on a small commercial oven scale. The initial results are encouraging. Preliminary work on a mathematical model of temperature distributions has been carried out at the Coal Research Establishment. The model has several advantages over the earlier work at the University of Berlin, and should be suitable to assist in optimizing programmed heating systems. The application of programmed heating in the UK may require different heating profiles to those developed by Bergbau—Forschung. In particular, it is not certain whether UK blends would be able to obtain the full advantage of the energy savings and high oven throughputs expected in Germany.

DESULFURIZATION AND PURIFICATION

REFER ALSO TO CITATION(S) 40795, 40863

40739 Agglomeration in coal preparation. Capes, C.E.; McIlhinney, A.E.; Sirianni, A.F.; Puddington, I.E. pp 63-76 of In Coal processing. New York; MSS Information Corporation (1976).

It has been amply demonstrated that oil agglomeration is particularly suited to the recovery of extremely fine coal from aqueous slurries. Regardless of the liberation size of the impurities or the source of the coal, sufficiently fine grinding followed by agglomeration yields upgraded products with high recovery. In addition, if larger agglomerates are produced, the coals are effectively dewatered, reducing or eliminating the need for thermal drying in fine coals. Regarding sulphur removal, it has been shown that bacterial oxidation during grinding, coupled with agglomeration, is a potentially valuable technique for removing pyrites from coals. Objections might be raised to the relatively large amounts of oil consumed in the agglomeration process. These objections are void, however, if one takes account of the upgrading achieved and of the higher calorific value of the hydrocarbon compared with coal. Economies in "real" fuel transportation, resulting from low ash and moisture, must not be ignored. In addition, the binder oil as a source of hydrogen might be attractive to some consumers. Admittedly, one must be prepared to think of the agglomerates as a "new" fuel, with energy coming not only from the coal portion but also from the hydrocarbon portion. This adjustment in thinking should be acceptable, especially in view of the growing shortage of low-ash, low-sulphur coals.

40740 Bacterial oxidation in upgrading pyritic coals. Capes, C.E.; McIlhinney, A.E.; Sirianni, A.F.; Puddington, I.E. pp 10-19 of In Coal processing. New York; MSS Information Corporation (1976).

Two main problems are associated with the removal of pyritic sulfur from coals. The first is due to the fine state of dissemination of pyrite, which requires grinding to a very fine size to accomplish liberation. The second problem is caused by the similar surface chemical characteristics of coal and pyrite, which complicates separation methods based on this property. In the work described, the problem of fine particle size was overcome by using the selective oil agglomeration method developed at the National Research Council of Canada. Recovery of more than 90 percent of the combustible values was possible, even with particles only a few microns in diameter. Experiments using conventional chemical depressants for pyrite met with little success. It was found, however, that pyrite may be rejected during coal agglomeration through treatment with the iron-oxidizing bacteria, thiobacillus-ferrooxidans. The conditions for maximum pyrite separation are described and possible mechanisms by which the bacteria act are discussed. Pyrite is rendered hydrophilic through the action of the iron-oxidizing bacteria,thiobacillus-ferrooxidans. The pH, which becomes naturally acidic during the pretreatment with bacteria, must be raised during agglomeration for greatest pyrite rejection. Only small amounts of pyrite are oxidized during the bacterial attack; the process apparently relies on surface oxidation to control wetting properties. Treatment times were of the order of 1 to 3 days, much less than the several weeks needed for removal of 50 percent of the pyrite from coals by bulk bacterial oxidation and leaching.

40741 Flotation of pyrite from coal: pilot plant study. Miller, K.J. pp 20-34 of In Coal processing. New York; MSS Information Corporation (1976).

Pittsburgh bed and lower Freeport bed coals were tested in the U.S. Bureau of Mines two-stage froth flotation pilot plant, which utilizes a new flotation process to remove pyritic sulfur. The process consists of a first-stage coal flotation step to remove coarse, free pyrite and other refuse in the tailings. The clean coal froth concentrate is then repulped and treated with a coal depressant, a pyrite collector, and a frother to selectively float the remaining pyrite in a second stage. Results in the pilot plant were excellent, comparing well with those obtained in laboratory batch tests. That is, about 70 percent of the pyrite present in the Pittsburgh bed coal and about 90 percent of the pyrite present in the lower Freeport bed coal were removed with excellent final clean coal recoveries.

40742 Chemical cleaning of coal. Friedman, S.; Warzinski, R.P. (US Energy Res and Dev Adm, Pittsburgh Energy Res Cent, Pa). *Am. Soc. Mech. Eng., [Pap.];* No. 76-WA/APC-2, 1-4(Dec 1976).

Between the expensive coal conversion processes and the relatively inexpensive flotation and magnetic methods for pyrite removal are the chemical methods for desulfurizing coal. Chemical cleaning removes more sulfur than physical separations, less than coal conversion, at costs and investment which are intermediate. Fuel value losses are small for chemical methods, comparable with the best of the physical separation procedures. In addition, certain chemical treatment methods effect useful changes in coal composition and properties. The principal chemical desulfurization methods involve treatment, at elevated temperature, with either basic media or oxidizing systems. Aqueous sodium hydroxide, at 225$degree$C, removes almost all of the pyrite from coal, while subsequent washing with dilute acid removes most of the remaining mineral matter. At 300$degree$C, similar treatment can remove, in addition, up to 40 percent of the organic sulfur from coals and also destroy caking properties. Oxidative desulfurization, using steam and air, also removes most of the pyritic sulfur and 20-40 percent of the organic

sulfur, under milder conditions than those required for alkali treatment. 13 refs.

HYDROGENATION

REFER ALSO TO CITATION(S) 40794

40743 (PB—254878) **Basic studies of coal pyrolysis and hydrogasification. Quarterly progress report No. 4, 21 Feb—20 May 1976.** Bush, T.W.; Howard, J.B.; Peters, W.A.; Suuberg, E.M. (Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.). 1976. 25p. NTIS $3.50.

During this reporting period, the low pressure batch sample reactor apparatus has undergone the final modifications necessary to accomplish total product analyses. Concurrently with the development of the low pressure system, the successful modifications have been incorporated into a design of the high pressure hydrogenation reactor. The analysis scheme for either reactor involves capturing products in four classes: (1) char; (2) gas; (3) condensible liquid; and (4) tar. The designs for many components of the laminar flow reactor were finalized. These components include the gas preheater, the coal particle feeder, the gas pressure and flow rate control system, and the process temperature control system. All these components will shortly be integrated into an operating unit suitable for pyrolysis and hydrogasification experiments at pressures up to 300 psig.

40744 **Mathematical description of the hydrocracking of distillates from the liquid-phase hydrogenation of coal.** Gagarin, S.G.; Zamanova, L.P.; Krichko, A.A.; Yulin, M.K. *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 1, 77-81(1976).

Using a computer, the results of a factorial experiment on the hydrocracking of distillates with bp 180-320°C from the liquid-phase hydrogenation of coal have been subjected to a kinetic and a mathematical-statistical treatment. On the basis of a regression model, the optimum conditions of the process leading to the maximum possible yield of gasoline has been determined. 10 refs.

GASIFICATION

REFER ALSO TO CITATION(S) 40798, 40799, 40811, 40813, 40814, 40834, 40854, 40855, 41169

40745 (MERC/SP—76/3) **Proceedings of second annual underground coal gasification symposium.** Shuck, L.Z. (ed.). (Energy Research and Development Administration, Morgantown, W.Va. (USA). Morgantown Energy Research Center). 1976. 600p. (CONF-760817—). Dep. NTIS, PC A25/MF A01.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

The Second Annual Underground Coal Gasification Symposium was sponsored by the Morgantown Energy Research Center of the US Energy Research and Development Administration and held at Morgantown, WV, August 10-12, 1976. Fifty papers of the proceedings have been entered individually into EDB and ERA. While the majority of the contribution involved ERDA's own work in this area, there were several papers from universities, state organizations, (industrial, engineering or utility companies) and a few from foreign countries. (LTN)

40746 (MERC/SP—76/3, pp 1-17) **1976 ERDA in situ coal gasification program.** Wieber, P.R.; Sikri, A.P. (Energy Research and Development Administration, Washington, DC). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

The status and plans of the ERDA in-situ coal conversion program are presented. Management, planning and overall technical direction are emphasized. The history of underground coal gasification up to the formation of ERDA is briefly outlined. In the 1970's, interest in underground gasification revived. Field projects at the Morgantown and Laramie Energy Research Centers were started by the Bureau of Mines and at the Lawrence Livermore Laboratory by the Atomic Energy Commission. These were combined under ERDA as the core of the present program. The various elements which affect the program strategy are presented and discussed. These elements include resources, product options and markets, expected economics, environmental impacts, technical options, and development paths to commercialization. All these elements are controlled by the constraints that in-situ coal processing is a field-located operation. Commercial feasibility may not only require process scale-up, but also proof that the processes are applicable to a number of sites with similar coal resources. The 1976 program status is reviewed: The major field projects are Linked Vertical Wells (LERC), Packed Bed (LLL), and Longwall Generator (MERC). Sandia Laboratories is providing instrumentation support to LERC. The program includes supporting research, and there are also university projects funded by Fossil Energy Research and some environmental studies funded cooperatively, by Environment and Safety.

40747 (MERC/SP—76/3, pp 18-35) **Feasibility of in-situ coal gasification in the Warrior coalfield; a progress report.** Douglas, G.W.; Beavers, W.M. 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

A two-year research effort is being conducted to determine the feasibility of in-situ gasification in the Warrior Coalfield of Alabama. This work is sponsored by the National Science Foundation. The Geological Survey of Alabama has located a preliminary test site on University of Alabama-owned coal lands and has begun geological studies of the area. A laboratory combustor has been constructed to investigate in-situ burning in cracks. Early tests show that forward burning in a swelling coal results in crack stoppage while reverse burning proceeds satisfactorily.

40748 (MERC/SP—76/3, pp 36-52) **Results and status of the second Hanna in situ coal gasification experiment.** Brandenburg, C.F.; Fischer, D.D.; Northrop, D.A.; Schrider, L.A. (Laramie Energy Research Center, WY). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

The second Hanna experiment has demonstrated the feasibility of successfully gasifying coal in-situ under controlled conditions. This experiment was designed as a three-phase study. The Phase I test showed that: (1) reverse combustion linking could be controlled; (2) the preferred flow direction was up-dip and along the minor fracture trend; (3) completion of wells near the bottom of the seam prevented gas overriding; (4) during a 38-day gasification test between two wells gas production averaged 2.7 MM scfd (8.1×10^4 scmd) of 152 Btu/scf (5.36 megajoules/scm) gas with consumption of 48 tons (44 tonnes) of coal per day. It was also determined that the system could be turned down by a factor of 10 with only a 20 percent drop in gas heating value with less than a 6-hour response time to bring the system back to full operation. Phase II consisted of linking two wells by reverse combustion and gasifying the coal between them. Because of the extensive instrumentation it has been shown that the linkage path is a narrow channel that can be placed at the bottom of the coal seam. Both diagnostic and remote monitoring techniques have been fielded utilizing a combination of instrumentation wells within the experimental region and near-surface arrays. The primary diagnostic information is obtained from extensive thermocouple arrays from which the location, extent, and movement of the combustion front is clearly evident. Gas sampling canisters, pressure transducers, tilt meters, and displacement gauges provide additional diagnostic information. Emphasis has been placed on the development of surface or remote instrumentation techniques based upon acoustic, seismic and electrical phenomena which would provide an overall picture or map of the changing process and which would be used in designing an overall process control system.

40749 (MERC/SP—76/3, pp 53-64) **LLL in-situ coal gasification program.** Stephens, D.R.; Beane, F.O.; Hill, R.W. (Lawrence Livermore Lab., CA). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

The conversion of coal into a clean, combustible gas can permit environmentally sound utilization of our principal fossil resource. If the conversion to gas can be accomplished with the coal underground (in-situ coal gasification) then additional environmental and economic advantages can be realized. In-situ coal gasification offers four potential advantages over conventional mining and subsequent surface processing: The product may be cheaper because of lower capital investment; environmental damage is likely to be lower; hazards to miners are avoided; and it may be possible to exploit coal resources found at depths too great to be economically attractive for conventional strip- or deep-mining operations. A unique approach to in-situ coal gasification was originated at LLL in 1972. In this approach, an array of chemical explosives is detonated to enhance the permeability of a reaction zone within a thick bed of coal (15 m or more). Our objective is to develop a commercial process for gasifying deep (150 to 1000 m), thick western coals to produce pipeline quality gas. A permeable, fractured coal bed within a relatively impermeable medium should permit intimate mixing of the coal and reactants (oxygen and steam) and allow heat transfer and reactant access to the coal. The low permeability of the sur-

roundings should minimize leakage of reactants and products from the fractured zone. Laboratory experiments, computational studies, and an extensive field effort are in progress.

40750 (MERC/SP—76/3, pp 65-85) **Status of the MERC in situ gasification of Eastern U.S. coals project.** Shuck, L.Z.; Pasini, J. III; Martin, J.W.; Bissett, L.A. (Morgantown Energy Research Center, WV). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

There are numerous coalbeds in the Eastern U.S. near the large energy demand centers which cannot be recovered by conventional methods. Most of these coals are the coking type which represents a different problem from subbituminous coal and lignite. It is these differences of coking, swelling and fluid phase transition that are considered to cause problems in conventional UCG schemes that are now being investigated in the MERC research program, to render feasible such new, innovative schemes as the Longwall Generator Concept. Variations of this concept, in conjunction with directional drilling, will hopefully add a new dimension to our means of recovering energy from the Eastern U.S. coalbeds.

40751 (MERC/SP—76/3, pp 86-89) **Texas utilities program status report.** Clements, B.R. 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

Texas Utilities Service has several lignite leases. They bought Russian know-how in underground gasification and made several trips to Russia to observe the techniques in practice. Their plans for in-situ gasification in Texas are described briefly. (LTN)

40752 (MERC/SP—76/3, pp 90-95) **Research on in situ gasification of Texas lignite at the University of Texas.** Edgar, T.F.; Kaiser, W.R.; Thompson, T.W. (Univ. of Texas, Austin). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

Underground coal gasification (UCG) is currently of great interest as an extraction method for Texas lignite, mainly for those deposits which lie below strip mining depth. The major deep-basin deposits occur in a broad arc which widens gradually from Gonzales County northeast to Cherokee County, where it splits and wraps around the north and south flanks of the Sabine uplift (Panola and adjacent counties). The important technical and economic factors for using UCG for recovery of Texas Lignite are discussed. The UCG research currently being conducted at The University of Texas at Austin currently involves the Departments of Petroleum Engineering, Chemical Engineering, Mechanical Engineering, Civil Engineering, and Geology. A description of activities in each disciplinary area is given. Of particular interest are projects on rock mechanics and permeability studies, environmental impact of UCG, methods of utilizing low Btu gas, and various chemical reaction studies, ranging from small-scale isothermal kinetics research to combustion tube experimental systems. Recent results of this research project are highlighted; more complete details are available in semi-annual reports issued by The University of Texas.

40753 (MERC/SP—76/3, pp 119-139) **Preliminary laboratory and modeling studies on the environmental impact of 'in-situ' coal gasification.** Campbell, J.H.; Washington, H. (Lawrence Livermore Lab., CA). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

A preliminary laboratory and modeling study on the environmental impact of in-situ coal gasification field testing is reported. Experiments were conducted on the aspects of ground water pollution; water leaching, transport, and dispersion of pollutants. The major inorganic contaminants leached from the coal ash were determined to be Al^{+3}, Ca^{+2}, and OH^{-}, while the principal organic pollutants were found to be phenols. A simple calculational model is used to predict the movement of the polluted ground water. This model uses information from laboratory experiments for the rate at which the above pollutants are removed from the gasification zone and the degree to which they are sorbed by the surrounding coal. It was discovered that ungasified coal has a strong beneficial effect on retarding the dispersion of the pollutants. The problem of air pollution resulting from the flaring of the production gas was also examined. The extent of the air pollution plume that develops from this flaring is predicted using a simple computer model. These predictions have been carried out for a set of atmospheric and flare operating conditions that may be encountered during field tests. It was determined that the LLL field experiments will adequately meet air quality standards, even under adverse conditions.

40754 (MERC/SP—76/3, pp 145-154) **Factors influencing the economics of large-scale in situ coal gasification operations.** Buder, M.K.; McCone, A.I.; Fisher, R.A.; Terichow, O.N.; Wong, M.J. (Bechtel Corp., San Francisco). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

In a feasibility study of large-scale underground coal gasification (UCG) plants, the preparation and operation of the UCG field were found to be major contributors to product costs. The costs of UCG fields were based on expenditures mainly for drilling, linking, gas collection, and oxidant injection. In-situ gasification costs, when compared to those of aboveground gasification, were generally found to be lower, in some cases by as much as 25 percent. Bechtel applied state-of-the-art UCG technology to conceptualize large-scale power and SNG plants, derive preliminary economics based on both eastern and western U.S. coal, and compare them to previously established costs for surface gasification. Since the cost estimates were conservative and there is ample room for technological advance in UCG, lower costs for in-situ gasification than those found by Bechtel are possible. Past studies have shown how parameters such as seam depth, seam thickness, and well spacing influence UCG economics. The results of this study point out that drilling and piping costs, which are related to the above parameters, have an important effect on overall costs for large-scale UCG operations. Where these and other UCG field costs begin to raise the cost of raw gas produced in-situ above the cost of raw gas from conventional gasifiers, it becomes clear that drilling and piping costs are governing parameters for UCG economics. In the study, for example, costs for power production using UCG in the East were high because the coal seam to be gasified was very thin and lay 1000 ft (305 m) deep.

40755 (MERC/SP—76/3, pp 155-168) **Economic evaluation of underground coal gasification.** Garon, A.M. (Gulf Research and Development Co., Pittsburgh). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

A computer-programmed economic evaluation was developed to include all of the components of a hypothetical commercial underground coal gasification installation. The capital requirements and operational expenses for production operations, gas purification plants, oxygen manufacture and air compression were obtained from Gulf experience and a variety of other sources. Data from Lurgi pressure gasification tests were used in the base case calculations for production gas quantities and compositions and for the oxygen requirements. Sales prices were determined for three different product gas options, water or steam injection and two different base cases. One base case represents gasification in Illinois using pneumatic linking and the other represents operations in Wyoming using linking by backward burning. The gas prices were determined as functions of the coal process parameters, the seam parameters, the operational parameters and the process efficiencies. Nominal values for these parameters were assumed for the base case calculations, and each of the parameters was varied relative to the base case values to determine its effect on the product prices.

40756 (MERC/SP—76/3, pp 169-178) **Economics of underground coal gasification.** Moll, A.J. (Stanford Research Inst., Menlo Park, CA). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

Two economic criteria must be met for underground coal gasification to be competitive. First, the product gas must be produced and transported to users at an attractive price compared with competitive fuels. Second, the value assigned to the coal gasified must be equal or greater than any alternate use for that coal. The alternate value of the coal in place depends on the mining cost, percentage coal recovery, coal transportation costs, and value to potential users. Financial and technical factors that are important to the required price for the gas are identified. The relative effects of investment, coal royalties, and other operating costs are compared. The effect of plant capacity on gas cost is found to be less than expected. The importance of requirements for air compression, well drilling, gas purification, and resource recovery efficiency are shown. The likely role of underground gasification in the energy picture is discussed. An analogy is drawn with geothermal steam.

40757 (MERC/SP—76/3, pp 179-187) **Economics of manufacturing synthesis gas produced by underground coal gasification.** Bidlack, D.L.; Arscott, R.L. (Gulf Research and Development Co., Pittsburgh). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

The major options for utilizing the products from underground coal gasification are very dependent on whether air or oxygen is used as the gasifying agent. If air is used, the low heating value gas produced is suitable only for local generation of electricity or use as a fuel in the vicinity of the gasifier. If oxygen is used, the medium heating value gas can be utilized for the manufacture of methane, as a chemical feedstock for such products as methanol or ammonia or as a fuel. This paper concentrates on the economics of marketing synthesis gas for the manufacture of methane, methanol and ammonia. The current and projected markets are examined together with the production and transportation costs. Currently the petrochemical industry utilizes 7.2 percent of the total U.S. natural gas production and the demand is expected to grow especially if methanol finds wide acceptance as a fuel. When this increased demand is coupled with the decreased supply of natural gas, the potential for synthesis gas derived from coal gasification becomes substantial. The capital requirement for underground production of methanol synthesis gas is only 65 percent of that required if the synthesis gas is made via Lurgi gasifiers in an aboveground facility. Methanol made from the underground produced gas costs $63/t ($57/ST) less than methanol synthesized from gas made in the aboveground plant. Similarly, the capital requirement for manufacturing substitute natural gas (SNG) via underground coal gasification is 76 percent of the capital requirement for an aboveground facility.

40758 (MERC/SP—76/3, pp 188-213) **Economic comparison of producing SNG by Lawrence Livermore Laboratory's in situ coal gasification process with Lurgi aboveground coal gasification.** Mason, R.Z.; Hall, D.E. 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

The in-situ coal gasification concept of the Lawrence Livermore Laboratory has been technically and economically appraised on paper by an industrial team consisting of the Resource Sciences Corporation, Amoco Production Company, E.I. du Pont de Nemours and Co., Inc., Pacific Gas and Electric Company, and Rocky Mountain Energy Company. The conceptual plan and the industry evaluation are summarized. The stoichiometry, field design, crude gas processing, utilities requirements and estimated investment and operating costs are discussed briefly. Problem areas to developing the technology are stressed. Economic appraisal of conservative and optimistic cases indicates that pipeline quality natural gas produced by this technology will be competitively priced with synthetic natural gas produced by other technology which is under consideration today if the assumptions made in the appraisal prove to be valid.

40759 (MERC/SP—76/3, pp 214-225) **Remote monitoring of an in situ coal gasification process.** Beckham, L.W.; Bartel, L.C.; Seavey, R.W. (Sandia Labs., Albuquerque, NM). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

Electrical resistivity, passive acoustic, and thermal measurements were made during Phase I of the Hanna II in-situ coal gasification experiment. The resistivity and acoustic techniques are under investigation for remote monitoring; the thermal measurements provide diagnostic information and correlation to the process. We present here: (1) the model for the electrical measurements derived from the nodal potentials in a resistance network chosen to represent the overburden, coal seam and underburden as well as representative calculations where the presence of various wells is taken into account; (2) comparison of field resistivity data and model calculations used to determine the path of the reaction zone; (3) models to determine the foci of discrete acoustic events based on compressional wave arrival times; and (4) source locations for acoustic events during gasification, which are in the overburden and are associated with subsidence and cracking over the gasified area. Correlations between the thermal data and the individual techniques result in a consistent picture of the overall gasification process.

40760 (MERC/SP—76/3, pp 226-237) **Real time process monitoring in underground coal gasification.** Eastwood, D.E. (Laramie Energy Research Center, WY); Eastlack, J.K.; Jennings, J.W.; King, S.B.; Lanum, W.J.; Moore, D.F. 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

The LERC Hanna II experiment uses a multiprogramming system for real-time data acquisition, analysis, and display. Within the framework of the real-time executive program for the computer, time-scheduled user programs are executed and data accumulated. The time scale of the experiment permits averaging of data over one-hour intervals, but the sampled data before averaging may be displayed or plotted for observation and control. The data include pressure, temperature, and flow information and on-line gas analyses. From this information, material balance and other calculations essential to an insight into underground processes may be calculated on demand. Computer control of the position of selected valves has also been utilized. Hourly averaged data are written into a disc file, which each midnight receives a name unique to the day just ended. The hourly history files are available for access by time-sharing programs, of lower priority than the data acquisition programs. A user file directory permits accumulation of information about the daily files, and makes the files easily transportable to another computer system. The real-time data acquisition and processing has permitted a degree of understanding and operator control which has contributed greatly to the success of the project.

40761 (MERC/SP—76/3, pp 238-241) **Electromagnetic wave propagation within a subsurface coal seam for in-situ gasification application.** Holmes, J.J.; Balanis, C.A. (West Virginia Univ., Morgantown). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

To aid in the design of an electromagnetic system for the detection, monitoring, and mapping of the burn front of an underground coal gasification (UCG) process, an analytical model has been developed that will predict the magnitude of the electromagnetic field reflected from the gasified portion of the coal seam. The coal and gasified section have been modeled electrically as lossy media, surrounded above and below by relatively high conducting overburden and underburden. Vertical and horizontal electric and magnetic dipole antennas have been investigated, utilizing a geometrical optics formulation which also takes into account the physical roughness of the coal-overburden (underburden) and coal-gasified section boundaries. Although the model is two-dimensional in nature, the results prove to be applicable.

40762 (MERC/SP—76/3, pp 242-248) **Monitoring of emissions from an in situ coal gasification experiment.** Fischer, D.D. (Laramie Energy Research Center, WY). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

Product gases produced from an in-situ coal gasification experiment conducted by the Laramie Energy Research Center (LERC) at Hanna, Wyoming, have been monitored for particulate matter content and the concentrations of fourteen trace components. Six monitoring periods for each component were conducted at the wellhead during distinctly different operating conditions in order to determine concentration changes during different times in the lifetime of a two-well system. The monitoring was conducted by Radian Corp. of Austin, Texas, under contract to LERC. Particulate matter in the product gas stream was monitored for particle size distribution as well as for bulk density and bulk elemental composition. The fourteen trace components which were monitored were carbonyl sulfide (COS), carbon disulfide (CS_2), ammonia (NH_3), hydrogen cyanide (HCN), mercury (Hg), lead (Pb), cadmium (Cd), arsenic (As), selenium (Se), sodium (Na), potassium (K), lithium (Li), vanadium (V), and calcium (Ca). The results are presented: They do not suggest any unforeseen problems.

40763 (MERC/SP—76/3, pp 249-255) **Numerical modeling of the stream method of underground coal gasification.** Farouq-Ali, S.M.; Pasha, M.L. (Pennsylvania State Univ., University Park). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

In the past, a series of analytical models of underground coal gasification by the stream method were developed. In order to extract a closed form solution the models necessitated a number of restrictive assumptions, including steady state combustion. The present model is a numerical extension of the previous models and is considerably more general. A channel of two-dimensional (r, x)

axisymmetrical geometry, in a coal seam, is considered. The channel is ignited at one end, and thereafter, gas is injected. As a result, the channel walls recede, and the combustion zone advances with time. Reaction kinetics are assumed to be diffusion controlled, and temperature and gas composition-dependent. The numerical solution used employs an implicit finite difference scheme. The resulting algebraic equations were solved by the Alternating Direction Implicit Procedure (ADIP). The moving coal boundary, being the result of erosive burning, was handled by means of a time-dependent coordinate transformation, which made the transformed boundary stationary in time, even though the actual boundary moved. This considerably simplified the numerical grid used, though at the expense of complicating the equations. This paper essentially gives the mathematical technique developed; numerical results are relegated to a later comprehensive report. The model is designed to be of immediate application to underground coal gasification schemes employing the stream method. In particular, it is intended to simulate the borehole linking phase of the underground coal gasification field test being conducted by the Morgantown Energy Research Center.

40764 (MERC/SP—76/3, pp 256-265) **Chemical reactor modeling of in situ coal gasification.** Edgar, T.F.; Tsang, T.H. (Univ. of Texas, Austin). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

Conceptual models for underground coal gasification (UCG) are discussed. A combustion tube, which embodies a one-dimensional representation of UCG, is to be tested as a means of verifying one scale-up step from laboratory kinetics data. A simple approach for modeling sweep efficiency in a combustion tube is given and preliminary simulation results presented. Problems of developing more realistic one- and two-dimensional models are discussed.

40765 (MERC/SP—76/3, pp 266-271) **Thermo-viscoelastic considerations associated with underground coal gasification.** Advani, S.H. (West Virginia Univ., Morgantown); Shuck, L.Z.; Lin, Y.T. 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

The mechanical properties of coal at elevated temperatures govern, to a large extent, the basic mass and energy transport phenomena associated with the Longwall Generator Concept of Underground Coal Gasification. Delineation of the thermoviscoelastic response is therefore fundamental to the understanding of the basic mechanisms controlling UCG flame propagation and stability. Simplified thermoviscoelastic response solutions for circular cavity and line drive models, incorporating Pittsburgh coal properties at elevated temperatures, are presented. Preliminary results from a two dimensional finite element structural model representation of the coke, softened layer, coal media are given. The response of coal fissures to pressure and temperature loading is also discussed.

40766 (MERC/SP—76/3, pp 272-284) **Theoretical analysis of Soviet in situ coal gasification field tests.** Gunn, R.D. (Laramie Energy Research Center, WY); Gregg, D.W.; Whitman, D.L. 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

The Soviet literature contains much field test data acquired at enormous cost. Because field tests are very expensive, it is important to make maximum use of these data. In all results considered here, there is good qualitative, and sometimes nearly quantitative, agreement between model predictions and the empirical correlations derived from Soviet field tests. It is possible, therefore, to deduce the chemical and physical basis for the behavior observed in these field tests. With the improved understanding derived from this study, the engineer can use the appropriate Soviet correlations as a qualitative guide to the design of underground coal gasification. The model provides a more concrete definition of the conditions and limitations implied by the correlations. At the same time it is possible with the aid of the model to develop quantitative correlations applicable to types of coal and to geological conditions different from those encountered in the Soviet Union. A review of the results of Soviet field testing of UCG and of the physical and chemical reasons for their occurrence leads to two important conclusions. First, a major controlling influence in UCG is the thermal energy balance. Factors which affect the thermal balance unfavorably are large heat losses from thin coal seams, loss of internal energy in the ash of high ash coal, and heat losses due to the vaporization of water. Second, excessive water influx into the combustion zone has been a major problem in the Soviet Union. It will probably present a major problem that must be remedied if UCG is to become a commercial process in this country.

40767 (MERC/SP—76/3, pp 285-294) **Calculation of fracture and permeability enhancement from underground explosions in coal.** Butkovich, T.R. (Lawrence Livermore Lab., CA). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

One- and two-dimensional computer programs are used to study explosive-induced fracturing and permeability enhancement. The total failure-induced deviatoric strain, a calculable parameter related to rock fracture, is used to correlate calculations with measurements. This parameter is made up of two parts, that associated with pure shear distortion and that associated with shear distortion from tensile failure. The total failure shear strain can be related to intensity of fracture, and the tensile portion can be related to the volume of tensile fractures. The latter value can be considered a measure of the crack volume generated following tensile failure. The calculations are correlated with measurements from field and laboratory experiments for both single and multiple explosions.

40768 (MERC/SP—76/3, pp 306-315) **Rock mechanics aspects of in-situ gasification with special reference to Texas lignite.** Thompson, T.W.; Gray, K.E. (Univ. of Texas, Austin). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

If the "in-situ" gasification of coal is to be achieved in a controlled manner, information is required on the behavior of the rock mass, and techniques must be available for the prediction of this behavior. Two aspects of the "in-situ" rock characteristics are important, firstly the fluid flow during the initial linking phase and secondly the stability of the overburden, with particular reference to its influence on any overlying aquifers and on surface subsidence. These aspects are reviewed, with particular reference to the gasification of Texas lignite, preliminary data on rock properties is summarized, and the significance of these data to the underground gasification process discussed. In the Rockdale region of Central Texas the lignite is overlain by a poorly cemented, weak sand, and it is probable that a similar overburden occurs in other localities. Early mechanical tests indicate that this rock has very low values of uniaxial compressive and tensile strengths, and a low deformation modulus. Early roof collapse seems inevitable, and it is important to be able to predict when this collapse will occur and in what manner and how far its effects will extend, since the Lignite is overlain in many places by producing aquifers, and roof collapse could have an appreciable effect on surface subsidence, especially in thick, shallow developments.

40769 (MERC/SP—76/3, pp 328-338) **Some observations from temperature measurements on recent underground coal gasification experiments.** Beard, S.G.; Reed, R.P. (Sandia Labs., Albuquerque, NM). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

Recent underground coal gasification experiments at the Laramie Energy Research Center field site at Hanna, Wyoming have been monitored with an array of subsurface thermocouples located in and near the coal seam. These temperature measurements are providing a quantitative basis for a specific understanding of thermal, chemical, and mechanical aspects of the underground gasification process. The subsurface measurements complement surface observations of process variables and allow direct deductions not available from surface measurements alone. This paper presents a description of the thermometry system, an example of data validation using diagnostic information provided by branched thermocouple circuits, and complete temperature histories from four instrument wells during the linkage, gasification, and cooldown stages of the Hanna II, Phase 1 experiment.

40770 (MERC/SP—76/3, pp 339-343) **Practical considerations in designing an UCG field test.** Humphrey, A.E.; Sterner, T.E.; Hutchinson, H.L.; Campbell, G.G. (Laramie Energy Research Center, WY). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

Experience gained over the past four years in underground coal gasification by personnel at the Laramie Energy Research

Center has shown the major areas of consideration for successful experiments are location and preparation of the test site, and operation of the test itself. Problems encountered during the selection, design and operation of the field test and some solutions to these problems will be discussed. In addition, the drilling, logging, dewatering and linkage techniques used at Hanna will be presented.

40771 (MERC/SP—76/3, pp 344-353) **Post burn analysis techniques applicable to underground coal gasification.** Boyd, R.M. (Laramie Energy Research Center, WY). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

An important consideration in process development for in-situ coal gasification is a means of measuring resource utilization and the location of the active combustion front by remote sensing. Efforts to develop measuring techniques applicable both during and after completion of a test burn have been underway at LERC for the past two years. Existing technology applied to post-burn evaluation has consisted of wire line drilling and coring, and conventional reflection seismic surveying. Research is underway to evaluate shear wave seismic surveying, high resolution shallow reflection seismic surveying, magnetic surveys to detect changes in iron minerals in the overburden as they are heated, and seam wave seismic surveys as means of real-time evaluation for process monitoring and control.

40772 (MERC/SP—76/3, pp 354-371) **Status of the Linked Vertical Well process in underground coal gasification.** Fischer, D.D.; Brandenburg, C.F.; King, S.B.; Boyd, R.M.; Hutchinson, H.L. (Laramie Energy Research Center, WY). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

The Linked Vertical Well process, which employs reverse combustion as a preparatory step to forward combustion gasification, will be described from both a practical and theoretical viewpoint. Fifty years of underground coal gasification experimentation has shown that, prior to efficient gasification, a "linkage" between injection and production boreholes must be prepared. The LERC experimentation has concentrated on the characterization and the development of reverse combustion linking such that it has become a predictable means of process control. The results of eight different reverse combustion links at Hanna indicate that subbituminous coal is ideally suited to reverse combustion linkage both from a controllability standpoint and the quantity of air needed to complete a linkage. Following reverse combustion linking, forward gasification ensues. Eight different well to well gasification periods have been completed since initiation of tests at Hanna. A detailed chemical and physical description of the recent results from Hanna II is given. This latter experiment resulted in the gasification of 6690 tons (6070 tonnes) of coal and production of up to 12 MM scfd (0.36 MM scmd) of 175 Btu/scf (6.2 megajoules/scm) gas. The reasons for these improved process results are discussed in detail.

40773 (MERC/SP—76/3, pp 372-379) **Utilization of low BTU gas from in-situ coal gasification for on-site power generation.** Stewart, R.E.D. (Sandia Labs., Albuquerque, NM). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

System studies are conducted which address the technological and economic aspects of utilization of low Btu gas from in-situ coal gasification for on-site power generation. Gas cleanliness requirements are established, and the applicability of commercially available gas cleaning processes/equipment is discussed. A parametric study of the thermodynamic efficiency of several power cycle configurations with various fuel inlet conditions and operating parameters is conducted. A typical low Btu fuel gas composition/heating value is assumed. The sensitivity of system performance to variations in fuel gas composition/heating value and production rate is also investigated, and some possible techniques for minimizing system sensitivity to such variations are discussed. A preliminary economic analysis using the discounted cash flow method is carried out to assess the relative economics of the various design alternatives for an integrated in-situ gasification/on-site power generation plant. Based on the results of the performance and economic evaluations, a conceptual integrated system design is established, and areas requiring further investigation are identified.

40774 (MERC/SP—76/3, pp 382-387) **In-situ gasification in Australia: prospects, potential, and research activities.** Stewart, I.M. (Univ. of Newcastle, Australia). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

The industrial area of Australia has large cheaply mined coalfields close to industry and to the coast. There are a number of deep, difficult or high sulfur seams which will be workable only by in-situ gasification. In South and West Australia considerable proportions of the limited coal reserves are likely to be won only by this method. Longer term cyclic or oxygen-steam gasification in-situ offers a high potential for low cost production of synthesis gas. We are building up a research program based on the borehole system which avoids the channelling difficulties expectable in broken-bed systems. Computer analysis of the terminal reduction zone and of well-stirred combustion zones indicates that a considerable minimum moisture content is desirable; that, particularly for moist coals, considerable reaction occurs within the coal bed; and that either cyclic water-gas operation or cyclic oxygen-steam gasification offer potential for high efficiency with this system.

40775 (MERC/SP—76/3, pp 388-401) **Prospects and problems for UCG in Britain.** Thompson, P.N.; Mann, J.R.; Williams, F. 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

The Operational Research Executive of the National Coal Board has reassessed Underground Gasification in the contexts of the present and predicted future energy supply/demand scenarios in Britain. For the immediate future, Britain's gas requirements will be met by natural gas drawn from the North Sea, but supplies are sufficient for only about 30 years. Alternative sources of gas will therefore be needed at about the turn of the century and UCG is judged to merit consideration as one possible source. Two proven methods of UCG were used as the basis for cost models to compare UCG gas with alternative fuels in terms of cost and resource utilization efficiency. The outstanding problems facing UCG in Britain are discussed and new methods of upgrading the product are suggested which could prove to be more economical than the methods considered in the past. Britain intends to maintain an interest in UCG, even though there is no immediate urgency for its development, and is now considering possible ways of collaborating with countries currently pursuing the development of UCG.

40776 (MERC/SP—76/3, pp 411-421) **Reaction kinetics of coal char gasification under conditions expected in underground coal gasification.** Young, J.E.; Lo, R.; Fischer, J. (Argonne National Lab., IL). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

Part of the Argonne National Laboratory energy program for ERDA is directed toward support studies for the national endeavor on in-situ coal gasification. The objective of this work is to determine the reaction-controlling variables and reaction kinetics for the gasification of chars resulting from pyrolysis of coal in underground gasification. The reactions to be studied include steam-char, CO_2-char, H_2-char, and the water gas shift reaction. Studies are described concerning chars prepared from subbituminous coals obtained from the Wyodak-Anderson and Hanna seams in Wyoming. These studies include physical characteristics defined by surface area measurements and scanning electron microscopy. Results are reported for the reaction of steam with these chars. Rate expressions are derived describing the reaction rate as a function of steam partial pressure, carbon consumption, and temperature. Pyrolysis of the coal under simulated underground gasification conditions results in a char with appreciably different characteristics from those of a char prepared externally to the reactor. The nature of these differing characteristics and their effects on the reactivity of the resulting char are discussed. The effects on these kinetics studies caused by the catalysis of the water gas shift reaction by the mineral matter present in the coal are also discussed. In addition, the kinetics of the hydrogen-char reaction in the range of temperatures and partial pressures of hydrogen and steam expected in in-situ gasification are described.

40777 (MERC/SP—76/3, pp 422-429) **Lawrence Livermore Laboratory coal gasification program: underground reaction modeling and laboratory combustion-tube experiments.** Rozsa, R.; Thorsness, C. (Lawrence Livermore Lab., CA). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

The in-situ coal-gasification concept currently under study at the Lawrence Livermore Laboratory calls for the fracturing of

thick, deep, coal seams by means of chemical explosives. The high-permeability zone created by the blast would be ignited and reacted with a steam/oxygen mixture to produce medium-Btu gas. This gas could then be upgraded to pipeline quality in conventional surface facilities. Calculational modeling and combustion-tube experiments have been carried out to evaluate the workability of the general coal-gasification concept, specifically to predict and correlate reaction and thermal-front propagation rates and product-gas composition as a function of bed properties and process operating conditions. The preliminary model considers only one-dimensional transient Darcy flow in a permeable packed bed. The normal conservation equations are coupled by chemical reactions and heat and mass transfer. The combustion tube, 1.6 m long and 0.15 m in diameter, is designed for conditions up to 6.9 MPa (1000 psi) and 1300°K. It is equipped with electric heaters to reduce radial heat losses. Results of a simulation of combustion-tube-reactor test runs are compared with observations. Good agreement is shown between calculated and experimentally observed reaction-front propagation rates as well as produced-gas compositions.

40778 (MERC/SP—76/3, pp 430-433) **Underground gasification at the University of Kentucky.** Hahn, O.J.; Jones, J.E. Jr. (Univ. of Kentucky, Lexington). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

It is proposed to gasify at least some of the coal left after auger mining, using the auger boreholes, and with a negative pressure in the gasification zone. Computer simulation results and laboratory studies are reported. It appears that the auger mining will enhance the permeability of the remaining coal and that temperatures above 480°C will be needed for gasification. (LTN)

40779 (MERC/SP—76/3, pp 452-466) **In Situ Hydrocarbon Recovery Simulation Laboratory research at Morgantown Energy Research Center.** Shuck, L.Z.; Fasching, G.E.; Martin, J.W.; Bissett, L.A. 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

The development of in-situ recovery processes whether in coal, oil shale, tar sands, petroleum and natural gas or geothermal type reservoirs can proceed along various paths. The most direct approach of immediately attempting a field-based recovery scheme is by far the most productive and enlightening into the real practical problems associated with the particular chosen reservoir and recovery scheme. However, even with substantial theoretical and practical engineering support, there are not only cost obstacles, but in some processes, limitations as to what can be observed from the field studies. By virtue of the remoteness, frequently only black-box input/output quantities are observable and measurable such that the real internal processes can only be hypothesized. Rudimentary field tests may quickly achieve a process efficiency plateau, which even through trial and error, may not be greatly improved upon. Further development may then depend upon a more basic scientific approach. This is the essence of the In-Situ Hydrocarbon Recovery Simulation Laboratory developed at the Morgantown Energy Research Center. Improvement in the overall total energy resource recovery efficiency of only a few percent could mean the difference of whether UCG is utilized in the U. S. on a large commercial scale.

40780 (MERC/SP—76/3, pp 467-670) **Ammonia injection scheme for fracturing and permeability enhancement of coal beds.** Datta, R.S. (Syracuse Research Corp., NY). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

Conventional methods of fracturing and/or increasing the permeability of coal, for either underground gasification, degasification or mining of coal, involves the use of underground galleries, boreholes, mechanical cutting or fragmentation using explosives, either separately or in conjunction with each other. The operations involved require an excessive energy expenditure and/or manpower. Chemical comminution, on the other hand, involves a selective fracture and/or increase in the permeability of the coal by the use of chemicals, for example ammonia, which are inexpensive, recoverable to a high degree, and operative under conditions which permit its utilization as an integral step in either an in-situ gasification scheme, underground mining system or in the degasification of coal beds. Since almost all of the ammonia is recoverable and only a few boreholes are required, this method promises to be cheaper than other methods. Moreover, because the upper and lower strata are not disturbed, the leakage of gases out of the bed and the influx of water into the bed can be more effectively controlled. Though the feasibility of the chemical comminution method as a coal preparation tool has been proved; a lot more work has to be done in the laboratory (and in the field) to prove the feasibility of the scheme presented. The technology developed has been patented in a series of disclosures covering applications in the cleaning and mining of coal. The term 'chemical comminution' has been applied to the process.

40781 (MERC/SP—76/3, pp 471-476) **Ignition of coalbeds for underground gasification.** Hermsen, R.W. (United Technologies Corp., South Windsor, CT). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

One of the most promising advanced concepts for underground coal gasification is the longwall generator scheme proposed independently by engineers in the USSR and at MERC. This method employs modern drilling techniques to produce a series of long (i.e., up to 3,000 ft.) horizontal holes through a coal seam perpendicular to the direction of major permeability. Alternate boreholes are ignited along their entire length and gasification is accomplished by reverse burning towards the non-ignited boreholes. As in longwall mining, greater total resource recovery efficiencies should be achieved, provided that ignition can be obtained uniformly over the entire length of the boreholes. If ignition is nonuniform or nonsustaining over a portion of the borehole length, recovery efficiency will be limited by premature burn-through and short circuiting of the borehole pattern. The longwall generator presents a unique problem in ignition technology. Because of the extreme length-to-diameter ratio of the boreholes (10^3-10^4), it is not clear which, if any, of several proposed methods will result in uniform ignition of the coal. Better understanding of the criteria governing the sustained ignition of in-situ coal surfaces is needed. Design methods must be developed to guide selection of the best technique, configuration and igniter parameters, such as heat flux, duration and composition.

40782 (MERC/SP—76/3, pp 477-488) **Review of current UCG model capabilities.** Sawyer, W.K. 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

During the past year, several ERDA-sponsored papers on UCG modeling efforts have appeared in the literature. As the Russians have done very little modeling work related to their field operations, it is believed that these papers represent the most rigorous, detailed mathematical models ever developed for in-situ coal gasification. However, many different simplifying assumptions have been made in these models as the work on the three projects has been essentially three independent efforts. These models are compared as to their merits and weaknesses and recommendations are made as to the nature of future modeling efforts. A second generation model is outlined which includes effects of liquid plugging, gravity segregation, and thermal losses to surrounding strata.

40783 (MERC/SP—76/3, pp 489-506) **Generalized theory for diffusive fluid flow through solid, permeable media.** Seeberger, J.F. (West Virginia Univ., Morgantown). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

In the last 15 years much work has been done on the mechanical theory of mixtures of superposed continua to represent the mechanical aspects of diffusion. In this paper the fundamental concepts are reviewed and the applicability of the theory to the flow of fluids and gases through porous solids is examined. A general three-dimensional constitutive theory is established for the partial stresses and the diffusive forces in the following cases: (a) the diffusion of a non-newtonian fluid through a non-linear elastic solid, (b) the diffusion of a newtonian fluid through a linear elastic solid, (c) the diffusion of a newtonian fluid through a rigid solid, (d) the diffusion of an ideal fluid through a linear elastic solid, and finally (e) the diffusion of an ideal fluid through a rigid body. The general 3-D equations of motion are evolved in each of the above cases as being the appropriate generalization of the commonly employed Darcy's law for flow through porous media. Cases where the more general framework reduces to Fick's Law or Darcy's Law are investigated. The object of the study is to supply a generalization, in less restricted circumstances, to the commonly employed Darcy's law as well as to exhibit the appropriate equations of motion in these circumstances. Two geometries that are felt to yield useful situations are the rectangular cartesian geometry as applicable to flow through coal beds, and the cylindrical geometry as applicable to well problems. It

is also pointed out that recently the mechanical theory has been extended to include thermodynamic fields as well as the possibility of the mixtures chemically reacting. Both of these extensions will be useful in the analysis now being carried out at U.S. ERDA in the underground coal gasification project.

40784 (MERC/SP—76/3, pp 507-518) **Surface directional permeability analyzer.** Huston, J.C.; Shuck, L.Z.; Slonneger, B.E. (Morgantown Energy Research Center, WV). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

An in-situ method is presented which predicts the directional permeability constants of porous reservoir rocks. To accomplish this, a fluid is injected through the center of the permeability analyzer which is placed on a smooth surface of the porous permeable medium. The resulting surface pressure distribution is then measured. A finite difference technique is used which numerically solves the governing differential equations obtaining the three-dimensional pressure distribution. The directional permeability is then determined by applying a modified three-dimensional form of Darcy's law. Tests were performed on Berea, Bradford, and Ohio sandstones and Pittsburgh coal to obtain the surface pressure distribution and the corresponding directional permeability constants. Oriented core samples were taken from the specimens tested to determine the validation/correlation of the directional permeabilities. The directional properties obtained by both methods were in agreement. The apparatus is portable, economical, and convenient which enables the researcher to perform on-site field studies. It is particularly useful in underground coal gasification where knowledge of the velocity and flow direction is essential in controlling the gas burn.

40785 (MERC/SP—76/3, pp 519-525) **Algorithm for cost effectiveness of directional versus vertical well drilling.** Slonneger, B.E. (Morgantown Energy Research Center, WV). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

The advantages and disadvantages of directional and vertical well drilling for underground coal gasification are well worth comparing. Basically, directional well drilling involves drilling a hole at a changing angle of inclination to a desired depth, then boring a horizontal hole the length of the coalbed. These are drilled in sets of not less than two wells. In vertical well drilling, vertical holes are spaced in two rows along the coalbed length and connected by burning through the coalbed. The cost ratio between the two methods involves the amount of pipe needed, the length of time for drilling and installation of the pipe, as well as the consideration of other factors influencing cost. Once the ratio of cost is established and compared for various depths of beds, number of vertical wells, and dimensions of gasification cells, the more economical method of drilling can be determined.

40786 (MERC/SP—76/3, pp 526-540) **Real mass and energy transport coefficients determined from UCG process simulation experiments.** Pellegrin, M.T. (Morgantown Energy Research Center, WV). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

In the study of in-situ gasification processes, it is of interest to know the relevant thermal transport properties of the coal. The thermal conductivity and thermal diffusivity would be expected to depend upon the type of coal, the moisture content, and size of the sample being gasified, the heat flow direction, and the coal temperature. In addition, mass transport mechanisms in the form of forward and reverse flows through the coal (relative to the burn direction) and diffusion properties of water already in the coal could affect the thermal transport properties. The probe method was used to determine the thermal conductivity and thermal diffusivity of eastern bituminous coal for temperatures up to 450°F (250°C). Forward and reverse flows were imposed on the sample during heating in order to simulate in-situ gasification conditions. The results were interpreted in terms of moisture content, sample size and orientation, and sample temperature. Spatial temperature distributions for forward and reverse flow were compared with those predicted by a steady-state model.

40787 (MERC/SP—76/3, pp 541-552) **Fundamental aspects of in situ electrocarbonization and electrogasification of coal.** Sarapuu, E. 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

The research of the process of underground electrocarbonization of coal conducted in laboratory and pilot-plant tests demonstrated that the process is feasible as a method of underground gasification and offers a means of solution of many of the problems that have attended other methods. Though the economics of the process as a whole depends on many factors such as cost of power, depth of fuel bed, thickness of seam, proximity and character of industrial activities, the research has demonstrated that underground electrocarbonization and electrogasification could assist the development of underground gasification for industrial scale application.

40788 (ORNL/TM—5411) **Assessment of very high-temperature reactors in process applications. Appendix III. Engineering evaluation of process heat applications for very-high temperature reactors.** Wiggins, D.S.; Williams, J.J. (United Engineers and Constructors, Inc., Philadelphia, Pa. (USA)). Apr 1977. Contract W-7405-ENG-26. 152p. Dep. NTIS, PC A08/MF A01.

Appendix III of ORNL/TM—5242.

An engineering and economic evaluation is made of coal conversion processes that can be coupled to a very high-temperature nuclear reactor heat source. The basic system developed by General Atomic/Stone and Webster (GA/S and W) is similar to the H-coal process developed by Hydrocarbon Research, Inc., but is modified to accommodate a nuclear heat source and to produce synthetic natural gas (SNG), synthesis gas, and hydrogen in addition to synthetic crude liquids. The synthetic crude liquid production is analyzed by using the GA/S and W process coupled to either a nuclear- or fossil-heat source. Four other processes are included for comparison: (1) the Lurgi process for production of SNG, (2) the Koppers-Totzek process for production of either hydrogen or synthesis gas, (3) the Hygas process for production of SNG, and (4) the Westinghouse thermal-chemical water splitting process for production of hydrogen. The production of methanol and iron ore reduction are evaluated as two potential applications of synthesis gas from either the GA/S and W or Koppers-Totzek processes. The results indicate that the product costs for each of the gasification and liquefaction processes did not differ significantly, with the exception that the unproven Hygas process was cheaper and the Westinghouse process considerably more expensive than the others.

40789 (PB—254836) **Coal gasification in southeastern Ohio: water supply and demand. Completion report.** Whitlatch, E.E. Jr. (Ohio State Univ., Columbus (USA). Dept. of Civil Engineering). Sep 1975. 84p. NTIS $5.00.

A general review of the need for coal gasification is made at the National level and for the State of Ohio. Current State energy policy promotes the construction of both low and high-Btu coal gasification plants. Water requirements of such an industry are estimated and water availability is determined for Southeastern Ohio. Direct stream use, reservoir and groundwater sources are compared economically. Linear programming optimization models are also developed for the coal gasification siting problem.

40790 (PB—255543) **Use of an interactive energy model for technology assessment with special reference to underground coal gasification.** Byrd, J. Jr. (West Virginia Univ., Morgantown (USA). Dept. of Industrial Engineering). 1976. 45p. NTIS $4.00.

The report will show how various decision criteria can be incorporated into a technology assessment model for new energy technologies using an interactive simulation model. Six steps for technology assessments are enumerated: (1) Define the assessment task; (2) Describe relevant technologies; (3) Describe the existing state; (4) Formulate alternative objectives; (5) Identify action options; and (6) Conduct impact analyses. Merit and utilization of this procedure are demonstrated in conjunction with underground coal gasification research. (GRA)

40791 **New concept for in situ coal gasification.** Higgins, G.H. pp 162-205 of In Coal I: current advances in coal chemistry and mining techniques. New York; MSS Information Corporation (1976).

A method is described by which deeply buried coals can be converted to methane through chemical reactions with oxygen and water. The coal would first be shattered with conventional explosives, then retorted with an oxygen-water mixture at between 700 and 1300°K. The reactants would be pumped into the top of the coal deposit at between 500 and 1000 psi and carbon dioxide and methane would be removed from the bottom. No sulfur gases or fly ash should be produced and the water requirements can be fulfilled from brackish water supplies. Coals available and suitable for this kind of gasification might yield as much as 10,000 trillion ft^3 of pipeline gas. This constitutes about 300 times the present annual consumption, and if the process is successfully developed, it could materially alleviate future gas shortages. Previous underground gasification has been accomplished with mined-gallery or drill-hole low-pressure burning. The method proposed here should minimize bypassing of the coal by the inlet gases and thereby maintain a high-quality product. This is

accomplished by flowing the reactant gases very slowly downward through the shattered coal, keeping the hot zones above the colder ones. This creates a thermally stable advancing hot zone and avoids the mixing of reactants and products. To test the feasibility of the proposed process it will be necessary to conduct further laboratory studies and calculations and to perform pilot field tests in suitable deep coal deposits.

40792 Supplemental pipeline gas from coal by the Hydrane process. Feldmann, H.F.; Wen, C.Y.; Simons, W.H.; Yavorsky, P.M. (Bureau of Mines, Pittsburgh). pp 150-182 of In Extraction of useful chemical derivatives from coal. New York; MSS Information Corporation (1976).

A two-stage process for the direct conversion of coal to pipeline gas is described. This process is distinct in two respects: first, no pretreatment to prevent coal agglomeration is required and second, over 90 percent of the total methane is produced by the direct reaction of coal with hydrogen rather than by extensive methanation of intermediate carbon monoxide. Since the process is based upon the direct reaction of coal with hydrogen to form methane, the only gas cleanup required is the conversion of the residual 3 to 4 percent carbon monoxide in the gas to methane by methanation and the removal of carbon dioxide, hydrogen sulfide, and dust. Experimental data supporting the process design are presented. Reactor configurations and sizes for a commercial plant producing approximately 250 million std. cu. ft./day of pipeline gas are estimated. Cost savings are estimated for the reduction in coal consumption brought about by avoiding pretreatment of caking coals.

40793 Some thoughts on coal gasification. Franzen, J.E. (Krupp-Koppers G.m.b.H., Essen (Germany, F.R.)). *Tech. Mitt. Krupp, Forschungsber.;* 35: No. 1, 83-94(Jan 1977). (In German).

9 figs.; 4 tabs.; 16 refs.

The commercial coal gasification processes using oxygen are explained. The Koppers-Totzek process for the entrained gasification of pulverized coal with oxygen is described. Its applications in the production of industrial gases for use in the chemical, iron and steel and power supply industries are outlined. A forecast for the future use of coal gasification is made.

LIQUEFACTION

REFER ALSO TO CITATION(S) 40788, 40900, 41639

40794 (FE—2307-13) **Research and development of rapid hydrogenation for coal conversion to synthetic motor fuels (Riser Cracking of Coal). Third Quarter Report, October 1—December 31, 1976.** Duncan, D.A.; Beeson, J.L.; Oberle, R.D. (Institute of Gas Technology, Chicago, Ill. (USA)). Jan 1977. Contract EX-76-C-01-2307. 32p. Dep. NTIS $4.00.

Construction of the bench-scale unit was essentially completed, and a preliminary run was made to test the equipment. Work with the cold flow model of the solids feeder was continued, and satisfactory test results were obtained with a 200 x 325 mesh particle size consist. Calculation methods for estimating system pressure drop were evaluated: Methods for isothermal compressible gas flow were found to be accurate, although methods for gas-solids systems were found to underestimate system pressure drop.

40795 (FE—2321-8) **Catalyst development program for hydrodesulfurization and liquefaction of coal to produce clean boiler fuels. Quarterly report, September—November 1976.** Hillenbrand, L.J.; Grotta, H.M.; Felton, G.W.; Alcorn, W.R. (Battelle Columbus Labs., Ohio (USA)). Dec 1976. Contract E(49-18)-2321. 25p. Dep. NTIS $3.50.

Several reports of current work in coal liquefaction were reviewed to enlarge our base of information for catalyst development. Some of the points of interest obtained in this way give experimental confirmation to concepts discussed in our proposal. Of the two primary catalyst functions now recognized for coal liquefaction, conversions of asphaltenes to oils and hydrodesulfurization of the product, the former will bear emphasis in initial work with the objective to extend catalyst life and improve selectivity so that hydrogen consumption is minimized. In light of a discussion with ERDA, Harshaw Chemical Co. has agreed with the desirability to broaden the objectives of their rapid screening program. It is anticipated that the newly designed screening unit, based on a stirred autoclave style reactor, will make use of much of the equipment ordered for the originally planned unit. Work has continued on construction of the Battelle SYNTHOIL Miniplant Reactor to be used for intensive screening of selected catalysts. Completion of the Miniplant is forecast for March or April, 1977. A 5-gallon sample of the currently preferred SYNTHOIL catalyst Harshaw CoMo 0402-T1/8, has been received at Battelle and work has proceeded to characterize it for use as reference and as the basis for whatever development is required. In the Quarterly Report results are reported for BET surface area, micro and macro pore size distribution, helium density, particle density, and electron microprobe operated in the X-ray dispersive mode.

40796 (PB—254400) **Catalyst development for coal liquefaction. Annual report.** Brooks, J.A.; Bertolacini, R.J.; Gutberlet, L.C.; Kim, D.K. (Amoco Oil Co., Naperville, Ill. (USA). Research and Development Dept.). Feb 1976. 120p. NTIS $5.50.

This report on project 408-1 covers work done from 1 March 1975 to 31 January 1976 on a three-year project to develop improved catalysts for the hydroliquefaction of coal to clean burning, electric power generating fuels. The specific purpose of this project is to develop one or more superior catalysts which could be used in processes currently under development of lower hydrogen consumption, better nitrogen removal or operation at lower pressure and temperature. This report includes a summary of the extensive literature search that has been completed, a description of the catalyst preparation and screening work, and results of batch autoclave screening tests. The pilot plant for the activity maintenance tests is also described as well as the range of operating conditions and plans for operation. (GRA)

40797 Model for the extractive coal liquefaction. I. Modeling and simulation of the NenKen coal liquefaction process. Fan, L.T.; Miyanami, K.; Fan, L.S. Manhattan, KS; Kansas State Univ. (1976). 33p.

A reaction model which is applicable to the extractive coal liquefaction process is presented. The effects of solvent diffusion and chemical reaction are taken into consideration in the model. The NenKen extractive coal liquefaction process is numerically simulated based on the model. The fractional extraction and concentration profiles of the hydrogen donor solvent, convertible solid and liquid product in the coal particle are numerically determined and the results are graphically presented. The available experimental data are employed to test the validity of the model. 20 refs.

PYROLYSIS AND CRACKING

REFER ALSO TO CITATION(S) 40744

40798 (CONF-770301—13) **Pyrolysis of large coal blocks: implications of heat and mass transport effects for in situ gasification.** Westmoreland, P.R.; Forrester, R.C. III. (Oak Ridge National Lab., Tenn. (USA)). 1976. Contract W-7405-ENG-26. 11p. Dep. NTIS, PC A02/MF A01.

From 173. national meeting of the American Chemical Society; New Orleans, Louisiana, United States of America (USA) (20 Mar 1977).

Dewatering of coal blocks at in-situ moisture levels was shown to markedly affect pyrolysis gas production by being the rate-limiting mechanism in heat transfer, and by causing self-gasification of the block as steam diffuses from a shrinking core of damp coal through a hot, outer layer of char. Cracking of product oil vapors as they diffuse outward may also contribute to the increased combustible gas evolution of block pyrolysis compared to powder pyrolysis. These results influence modeling and design of in-situ coal gasification. Since no data are available on coal-block pyrolysis, improved understanding of heat and mass transfer effects significantly improves semitheoretical models which have depended on powder pyrolysis data. For satisfactory resource recovery, the shrinking core of unreacted coal makes it critical to limit flame-front speed. If the flame front moves too fast, only an outer layer of any large masses of coal will be gasified, leaving damp, ungasified centers behind the front. More experimentation is planned to quantify and expand these results. Specifically, a matrix of experiments is being performed at 0.3°C/min and at 3.0°C/min, proceeding to maximum temperatures of 500 to 1000°C. Analyses will be made of data on oil, char, and gas yields; oil, char, and gas compositions; thermal histories; and oil and gas physical properties. Later experiments are planned to investigate the effects of pressure, reducing gas atmospheres, and other coal ranks (lignites, caking and noncaking bituminous coals). The ultimate result is a satisfactorily accurate model of pyrolysis as it affects in-situ coal gasification.

40799 (MERC/SP—76/3, pp 402-410) **Two-dimensional studies of coal pyrolysis: preliminary results.** Forrester, R.C. III. (Oak Ridge National Lab., TN). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

Two-dimensional pyrolysis behavior of large, instrumented blocks of subbituminous coal has been examined recently in studies conducted at the Oak Ridge National Laboratory (ORNL) in support of in-situ coal gasification process development. Pyrolysis studies have traditionally dealt with small coal particles which were heated rapidly; but, by contrast, in-situ gasification involves slow heating of large coal blocks resulting from permeability enhancement operations or, perhaps, roof collapse. Experiments utilizing

maximum reactor temperatures of 500° to 1000°C achieved over 4- to 50-hr time periods have produced data correlating tar and gas production rates and composition with maximum temperature and heating rate. The specific objective of the ORNL program supportive of underground coal gasification (UCG) development is the generation of data describing pyrolysis of large coal blocks under conditions which can be expected to occur underground. Such data can be used both in the development of computer codes that describe underground reactions and in the interpretation of field test results.

40800 Thermal transformations of coals and some coal-graphite materials. Zil'berbrandt, A.M.; Korovkina, L.A.; Novikova, N.V.; Rogailin, M.I.; Farberov, I.L. (Inst of Combust Miner, USSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 1, 40-45(1976).

In the reported experiments, the thermal degradation of coals and coal-graphite materials based on them on heating to 1000$degree$C has been investigated by derivatography and pyrolysis. The nature of the gas evolution by coal-graphite materials and the composition of the gaseous products has been studied chromatographically, and a materials balance of the pyrolysis products has been drawn up. The results of derivatography and the characteristics of the evolution of gases has permitted the recommendation of optimum conditions for the firing of carbonaceous materials. The most suitable materials for obtaining CGMs (coal-graphite materials) without additives are concentrates of Kuznetsk K2 and K13 coals. The use of Donetsk Zh13 coal is possible only with the use of leanness-imparting additives. 8 refs.

SOLVENT EXTRACTION

REFER ALSO TO CITATION(S) 40900

40801 (PB—255550) **Laboratory analysis of solvent refined coal. Technical report No. 1.** Borio, R.W. (C-E Power Systems, Windsor, Conn. (USA)). Jun 1976. 56p. NTIS $4.50.

With respect to air pollution control in electric power generation, two basic routes are being pursued; one is to clean up the flue gas before admitting it to the atmosphere and the other is to clean up the fuel before it is burned in the utility boiler. Southern Services Company has been actively pursuing a Solvent Refined Coal (SRC) process and has completed construction of a pilot plant at Wilsonville, Alabama in late 1973. The Southern Services process solubilizes about 95 percent of the moisture-ash-free coal in a dissolver operated at 1800 psig and 825F with a residence time on the order of 30 minutes. Combustion Engineering, under EPRI funding, has agreed to conduct a bench-scale analysis of the solvent refined coal (and base coal) produced by Southern Services' Wilsonville pilot plant. The objective of this study is to determine, within the limits of bench-scale analysis, the technical feasibility of using Southern Services' SRC as a utility power plant fuel. (GRA)

40802 (PB—2557029) **Solvent refined coal evaluation: pulverization, storage, and combustion. Technical report No. 2.** Borio, R.W.; Fink, Z.J.; Goetz, G.J.; Haas, J.C. (C-E Power Systems, Windsor, Conn. (USA)). Jun 1976. 124p. NTIS $5.50.

A laboratory analysis revealed several important characteristics of SRC that could affect its pulverization. It was determined that SRC melts at 310F. In normal mill operation, preheated air as hot as 700F is frequently used; therefore, a problem due to melting of SRC in the mill could exist if the preheated air temperature were over 310F. The Hardgrove grindability index for SRC is 145, indicating that the power required to pulverize SRC should be significantly less than that required for base coal. During preliminary testing in the Hardgrove grindability apparatus, SRC which had moisture contents of 5% or less was compacted rather than pulverized. It appeared from these tests that moisture was an important property with respect to pulverization. The pulverization of SRC was investigated using a C-E Deep Bowl Mill, No. 271. (GRA)

BY-PRODUCTS

REFER ALSO TO CITATION(S) 40847, 41869

40803 Tasks of scientific investigations in the field of waxes and accompanying products. Bel'kevich, P.I. (Peat Inst, Acad of Sci of the B SSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **9**: No. 6, 1-3(1975).

An account is given of the main tasks of scientific investigations in the field of the production of waxes and accompanying products from brown coal and peat in the USSR. The uses of benzene and other organic solvents for the extraction of parafin waxes from peat and lignite is also discussed.

40804 Some questions of the nonfuel processing of brown coals of the Dneprovskii basin. Shnaper, B.I. (Semenovka Montan Wax Fact, USSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **9**: No. 6, 4-7(1975).

The results are considered of scientific investigations and applied work in the field of the nonfuel utilization of the Dneprobass (Dneprovskii basin) brown coals. The experience of the work of the Semenovka montan wax factory on the production of montan wax and the coal-alkali reagent is described. Considerations are expressed on methods of intensifying the processes of obtaining montan wax and coal-alkali reagents. 22 refs.

40805 Extraction resins of brown coals. Golovanov, N.G. (All-Union Sci-Res and Des Inst of the Chem Ind, USSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **9**: No. 6, 8-13(1975).

The results are considered of the work of various authors on the composition and properties of extraction resins of brown coals (lignites) and also the field of their utilization. The necessity has been shown for performing investigations on the further isolation and identification of the compounds present in the resins (resin acids, resin hydroxy acids, resin alcohols, terpenes, polyterpenes, phenols, tanning and dyeing substances, coumarins, furocoumarins, esters, higher fatty acids and alcohols, etc.), on their genesis, and on the rational utilization of the extraction resins. 71 refs.

40806 Raw materials resources for the production of brown-coal wax. Zharova, M.N.; Serova, N.B. (Ministr of the Coal Ind of the USSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **9**: No. 6, 14-20(1975).

Material is presented which characterizes the bituminous brown coals as a raw materials basis for the production of brown-coal wax. Possible regions and methods of organizing the industrial production of crude brown coal wax are suggested. It is pointed out that with the exception of the deposits of the Dneprovskii basin, at the present time there are no accurate estimates of the resources of bituminous coals in USSR, the areas with a distribution of highly bituminous coals have not been outlined, the reserves have not been calculated, no conditions have been set for the quality of brown coals as a raw material for the industrial production of montan wax, and there is no standard method for testing coals for their bitumen content in prospecting operations and in calculating reserves. 12 refs.

40807 Investigations of the bitumens of solid fuels under the electron microscope. Lishtvan, I.I.; Terent'ev, A.A. (Peat Inst, Acad of Sci of the B SSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **9**: No. 6, 60-63(1975).

In the reported experiments, brown-coal and peat bitumens have been studied by electron diffraction and electron microscopy. It has been shown that the bitumens, ester waxes and paraffin waxes are identical crystallographically but differ in the supermolecular structures formed by the crystalline phase. Depending on the type of solvent and the raw material used it is possible to obtain different types of structures possessing different physicomechanical properties. 7 refs.

40808 Use of brown coals after the extraction of the montan wax for the production of sulfomethyl derivatives. Zabramnyi, D.T.; Pobedonostseva, N.I.; Pobedonostseva, O.I. (Inst of Chem, Acad of Sci of the Uz SSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **9**: No. 6, 74-76(1975).

The possibilities of using the residual coals after the extraction of montan wax for obtaining sulfomethyl derivatives are discussed. The advantage of the sulfomethylation reaction over sulfonation in the use of coals with a high content of humic acids has been shown. The optimum conditions for obtaining sulfomethyl derivatives have been worked out. 4 refs.

40809 Investigation of the composition and possible methods of using extracts of tertiary brown coals of the Southern Urals Basin. Levin, I.S.; Barnyakova, T.A. (S.M. Kirov Urals Polytech Inst, USSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 1, 46-49(1976).

The results are given of an investigation of the composition and properties of extracts of Southern Urals Brown coals, a method for their fractional extraction in order to obtain simultaneously resin-free waxes and resins is described, and methods for their possible utilization are considered. Industrial tests have been performed of the crude bitumens and the products of fractional extraction in the production of technical rubber articles, phonograph disks, carbon paper, and shoe creams, and the possibility of their replacement of imported montan wax and of a number of softening agents has been shown. The presence of large reserves of highly bitumenized brown coals in the Southern Urals, the operation of an open-cast coal mine and of a briquetting factory, and the existence of a large power station in Kumertau form the prerequisites for the creation of an industry for the production of montan wax and associated products in this area. 8 refs.

40810 Oxyethylation of the phenols and carboxylic acids of the low-temperature tars from the thermal treatment of coals. Fridman, G.E.; Semenko, M.G. (Inst of Combust Miner, USSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 1, 70-72(1976).

Results of an investigation are presented which show that the reaction of ethylene oxide with the technical phenols and carboxylic

acids of the tars from the low-temperature treatment of coals has given products with different amounts of oxyethyl groups which possess well-defined surface-active and other valuable properties. These products are free from the peculiar unpleasant odor of the phenols and the acids and of the tars from the thermal treatment of solid fuels. By changing the number of oxyethyl groups introduced into the mixture of technical phenols and acids it is possible to obtain products with given properties.

40811 Extraction of useful chemical derivatives from coal. New York; MSS Information Corporation (1976). 188p.

Five articles from the book, "Extraction of Useful Chemical Derivatives from Coal," have been entered individually into EDB and ERA. The articles deal with coal tar processing, the HYDRANE coal gasification process, the ultraviolet spectra of the ten isomeric naphthalene dicarboxylic acids, etc. (LTN)

40812 Low-temperature lignite tar: processing and utilization. Berber, J.S.; Rice, R.L.; Spencer, J.D. pp 22-149 of In Extraction of useful chemical derivatives from coal. New York; MSS Information Corporation (1976).

Acids, neutral oils, and pitch were produced by distillation of low-temperature lignite tar and processed to upgrade them into more valuable products. The acids were separated from the distillate and catalytically dealkylated to produce phenol, cresol, and xylenol. Aromatic and naphthene fractions of the neutral oil were converted into phthalic and maleic anhydrides by catalytic hydrodealkylation and vapor-phase oxidation. Paraffins and n-olefins from the neutral oil were processed into alkybenzene sulfonate, a biodegradable substance. Aromatic materials from the neutral oil were also extracted with organic compounds and the extract hydrogenated under pressure to produce jet fuel. The pitch was processed by various means to change its characteristics and make it suitable for similar applications as high-temperature tar pitch, including preparation of carbon black and metallurgical electrodes. In most cases, products obtained from the low-temperature tar were examined for physical and chemical characteristics and for potential commercial utility. Information obtained from this research would be helpful if a new coal-chemical industry based on tar utilization were established.

PROPERTIES

REFER ALSO TO CITATION(S) 40731, 40734, 40735, 40747, 40765, 40768, 40772, 40800, 40805, 40806, 40807, 40866, 40889, 40904, 40909, 41639, 41875, 41876

40813 (MERC/SP—76/3, pp 295-299) **Design criteria for hydraulic fracturing of coal beds.** Advani, S.H. (West Virginia Univ., Morgantown); Shuck, L.Z.; Chang, H.Y.; GangaRao, H.V.S. 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

The method of hydraulic fracturing, conventionally used for secondary stimulation of oil and tight gas reservoirs, has not been rigorously applied to coal seams. As a result, design criteria for predicting critical fluid pressures for fracture propagation and fracture orientations in terms of tectonic and overburden stresses, relative coal cleat orientations, coal bed geometric and material properties are lacking. The objective of this work is to formulate criteria for hydraulic fracturing of coal beds from the vantage point of fracture mechanics. Governing equations and numerical results for vertical fracture initiation, extension, and inclination are given. Critical pressures for hydraulic fracture initiation and extension are presented in terms of the primitive stress fields, geometry, fracture orientation, and material properties. Fluid flow considerations for incorporation in the structural models are also discussed. Hydraulic fracturing of coal seams can play a significant role in enhancing the permeability of coal beds and thereby permit efficient methane drainage and/or suitable well linking for underground coal gasification.

40814 (MERC/SP—76/3, pp 300-305) **Hydraulic fracturing thin coal seams in preparation for in situ gasification.** Warren, T.M.; Hayatdavoudi, A. 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

It has been shown that under certain conditions the fracture direction of a coal seam may be controlled by the joint system of the coal bed. When this occurs, the fracture direction should be consistent from well to well and can be predicted by the method discussed. A method has also been developed to calculate the principal horizontal stresses and their direction when the coal fractures along the cleat direction and the pore pressure is known. This information can be utilized to design a well pattern for underground coal gasification that will result in successful linkages between the wells.

40815 (MERC/SP—76/3, pp 316-327) **Mechanical properties of coal for simulation of underground gasification processes.** Shoemaker, H.D.; Shuck, L.Z.; Haynes, R.R.; Advani, S.A. (Morgantown Energy Research Center, WV). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

Mechanical properties of coal have been determined in an effort to advance in-situ gasification processes. Experiments and apparatus were developed to evaluate the directional compressive and shear properties of coal at elevated temperatures. Both creep and stress-relaxation experiments were conducted to evaluate the viscoelastic properties in compression and shear, at temperatures between 75° and 650°F (24° and 343°C). The directional experiments involved loading and or deforming the specimen normal to the bedding planes, face cleats, and butt cleats; and on four different specimen sizes. Stress-strain relations and ultimate strengths were also determined at three different loading rates for these directions, specimen sizes, and temperatures. A time-temperature superposition shift function was used to represent the viscoelastic properties of coal. Four- and six-parameter viscoelastic fluid models and empirically derived polynomial representations are available for viscoelastically modeling coal as functions of temperatures. Shallow and deep mine coal from the Pittsburgh coalbed were tested. The Pittsburgh coal was found to have the greatest ultimate strength and elastic moduli at 200°F (93°C) in both compression and shear, regardless of the orientation of loading or the loading rate. The ultimate strength in the normal to coalbed direction was approximately twice that in the face and butt cleat directions, independent of temperature. The ultimate strength is dependent upon the specimen size and loading rate. As the specimen size decreases, the strength increases; and as the loading rate increases, the strength increases. The ultimate strain is relatively constant for temperatures below the softening stage. At 575°-650°F (302°-343°C) the coal becomes fluidic, coalescent, and is well represented by a four-parameter fluid. Coal also obeys the time-temperature superposition principle.

40816 Electrometric method of finding spontaneous heating sites in coal. Miller, Yu.A.; Belaventsev, L.P. (East Sci-Res Inst, Kemerovo, USSR). *Sov. Min. Sci. (Engl. Transl.);* **11**: No. 6, 739-742(1975).

Temperature and electrical resistivity distributions along the heat flux due to a heater sited at the center of the solid or crushed coal are registered. The readings of the resistance thermometers are taken by means of an MKMV dc bridge, and the resistances of the coal between the electrodes are measured by means of an MOM-3 electronic megohmmeter for every 10$degree$ rise in heater temperature. The results reveal that the maximum temperature is observed in the region of the heater, and the temperature decreases with distance from it. At 25-30 cm from the heater the coal temperature stabilizes and becomes almost equal to that of the surrounding medium. The distance at which one observes the coal temperature to be higher than the 'background' increases with the heater temperature. This is due to the properties of the coal, in particular to its thermal conductivity and thermal diffusivity, which increases with the temperature. 1 ref.

40817 Feasibility of combined determination of the natural and residual methane content of a coal seam, the methane pressure in the seam, the sorption isotherms, and the gas emission kinetics. Muchnik, S.V. (Inst of Min, Acad of Sci of the USSR, Novosibirsk). *Sov. Min. Sci. (Engl. Transl.);* **11**: No. 6, 759-762(1975).

Experiment to calculate a group of parameters from minimal initial data is described. It is shown that the method can capture comparatively fine nuances of the state of the coal--gas system round the working. Agreement is obtained between the sorption isotherms recorded from a single sample in both field and laboratory conditions, showing that the sorption properties of the coal for methane are the same whether in the seam or injected in the laboratory. 4 refs.

40818 Question of the study of the tendency of peats to undergo oxidation and spontaneous combustion. Karaseva, E.Z.; Shvarts, N.M.; Zil'berbrandt, A.M.; Rakovskii, V.E. (All-Union Sci-Res Inst of the Peat Ind, Moscow, USSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **9**: No. 6, 99-102(1975).

In the reported investigation, a number of indices characterizing the tendency of peats to undergo oxidation and spontaneous combustion has been determined: the content of substances with active oxygen (peroxides), the ferrous oxide content, and the total content of acid groups. The tendency to oxidation has been determined by the perhydrol method. The results of a derivatographic investigation have shown that high-moor peats containing oxygen in organic compounds of aliphatic nature lose it earlier and in greater

amount than low-moor peats containing oxygen in compounds of aromatic nature. 6 refs.

40819 Determination of the rate of chemosorption of oxygen by coals. Al'perovich, V.Ya.; Chuntu, G.I.; Pashkovskii, P.S. (All-Union Sci-Res Inst of Mine Rescue Work, USSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **9**: No. 6, 103-106(1975).

In the reported experiments, the influence of the grain-size composition of coals on the rate of chemosorption of oxygen has been investigated. An equation has been obtained for the approximate calculation of the values of the rate constants of the sorption of oxygen by coals in piles from the results of chromatographic tests of laboratory samples of them. 5 refs.

40820 Question of the determination of the apparent density of brown and hard coals. Svyatets, I.E.; Agroskin, A.A. (Ukr SSR Sci-Res Inst of Coal Enrich). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **9**: No. 6, 107-112(1975).

The apparent density of a coal is one of the most important indices of its physical properties, the determination of which is necessary in mining and processing operations. The apparent density is used to estimate stocks and in the accounting of the coal-mining process, in calculating its stability in slopes and stacks, in determining the mining pressure and the distribution of stresses due to its inherent weight, the stability of rock slides and breastwalls, and other calculations. The true and apparent densities are also necessary for determining the porosity of the coal, which is an important technological characteristic of it used for calculating a number of industrial processes and apparatuses. In this paper, the influence of the moisture content of coal on the apparent density has been shown, and a mathematical relationship between the apparent and true densities and the moisture content has been derived. 14 refs.

40821 Study of the fire risk of brown coals of the Kharanorskoe deposit. Burkov, P.A.; Aleksandrov, I.V.; Borodin, B.A.; Ivashkin, V.S.; Kamneva, A.I. (D.I. Mendeleev Moscow Inst of Chem Technol, USSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 1, 6-10(1976).

In the reported experimental investigation, the influence of the conditions of mining and of meteorological factors on the spontaneous combustion of the coals of the Kharanorske deposit has been studied. A comparative evaluation of the tendency of the coals to undergo oxidation by various methods is given. The results of a determination of the tendency of the coals to undergo spontaneous combustion by various methods correlate well with one another. A definite tendency is observed to an increase in the activity of coal from the roof to the floor of the bed and from the technical limits of the area of an open-cast working to the center. Coals of the bottom of the 'Novyi-la' bed, which are broken up by carbonaceous and clayey argillites, have the greatest activity. 6 refs.

40822 X-radiographic study of the structure of anthracite and its change on thermal treatment. Filipchuk, I.G.; Yur'ev, G.S.; Ostashevskaya, N.S. (Inst of the Physicochem Princ of the Process of Miner Raw Mat, Acad of Sci of the USSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 1, 18-22(1976).

In the reported study, a diffraction experiment has been performed, and on the basis of the radial distribution function of the atoms, the change in the atomic structure of anthracite as a function of the degree of its thermal treatment has been investigated. It is demonstrated that the structure of the first two coordination spheres in the atomic radial distribution curves in anthracites calcined at 1300-1400$degree$C are close to the structure of the spheres of the crystalline state of carbon (graphite). The absence of third coordination sphere characteristic of graphite from the structure of anthracite and thermoanthracite and the appearance in the anthracite of a fourth coordination sphere due not only to an ordering in the carbon lattices but also to an approach of the lattices to one another have been observed. 6 refs.

40823 Investigation of the floatability of coals of different ranks by measuring the heat effects of wetting. Popova, L.A.; Petukhov, V.N. (G.I. Nosov Magnitogrsk Min and Metall Inst, USSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 1, 23-25(1976).

The results are given of an investigation of the surface of coals of different ranks and the nature of their interaction with hydrocarbons of different compositions by measuring the heat effects of wetting when the coals under investigation are immersed in hydrocarbon liquids. It is shown that for all the reagents investigated, the greatest heat of wetting is possessed by fat coals of a low degree of purification. For the majority of coals and reagents investigated, a greater heat of wetting corresponds to a greater extraction of the combustible mass into the concentrate. The heat effects in the wetting of coal of the same technological type depends on the composition of the wetting liquid and change in accordance with their chemical activities in the sequence: saturated < unsaturated < aromatic hydrocarbons. 7 refs.

40824 Influence of various factors on the change in the tensile strength of coke. Filonenko, Yu.Ya.; Shifrin, V.A. (Lipetsk Polytech Inst, USSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 1, 26-29(1976).

In the reported experimental study, changes in the ultimate tensile strength of coke at the temperature of its production as a function of the type of initial coal, the composition of the coal charge, the coking temperature, and the conditions of the preliminary thermal treatment of the charge have been investigated. The results of the experiments show a uniform rise in the tensile strength of the coke with a rise in the temperature of its production, which is in harmony with information in the literature. It is demonstrated that the nature of the structure of coke is affected by the preliminary thermal treatment of the coal. In particular, coke obtained from a charge previously subjected to thermal preparation is characterized by a denser structure and contains an increased number of coarse pore walls. A table gives information on the influence of the preliminary thermal treatment of the charge on the limiting tensile strength value of the coke. 5 refs.

40825 Anisotropy of anthracites from the results of a study of microhardness. Posyl'nyi, V.Ya.; Trostnikov, A.A. (Novocherkassk Polytech Inst, USSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 1, 30-33(1976).

A study of microhardness has shown that the vitrinite of anthracites is characterized by a distinct anisotropy, which is particularly well expressed when a diamond pyramid with a rhombic base is used for the measurements. The anisotropy of the hardness rises with an increase in rank, and in the anthracites of the same rank it falls as the result of an influence of sea water on the peat bed. The nature of the anisotropy and its change in the coalification sequence are explained by the development of orientation effects which influence the spatial position of the linear sections of the macromolecules. 4 refs.

40826 Pyrolytic mass spectrometry of coals at low ionizing voltages. Bychev, M.I.; Zvegil'skii, D.S.; Belokon, V.G.; Matyskin, V.I.; Gorlach, N.G.; Zhuravlev, V.I. (0301;400104). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 1, 34-39(1976).

The possibility has been shown of investigating the products of the thermal degradation of coal by pyrolytic mass spectrometry using coking fat coals as examples. A distribution of C$sub n$H$sub 2n+2$, C$sub n$H$sub 2n-12$, and C$sub n$H$sub 2n-26$ hydrocarbons with respect to the mol. wt in the degradation products have been obtained. It has been shown that the individual groups of the peaks arranged in order correspond to compounds of different series of hydrocarbons (with different degrees of hydrogen unsaturation) having the same numbers of carbon atoms. The presence in the products of the degradation of coals of methane hydrocarbons (from CH$sub 4$ to C$sub 8$H$sub 18$) and of naphthalene hydrocarbons has been established, which permits the assumption of the presence of the same fragments in the organic substances of coking and fat coals. 15 refs.

40827 Thermal breakdown of coke in the cooling process. Filonenko, Yu.Ya.; Kurbatov, A.V. (Lipetsk Polytech Inst, USSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 1, 50-53(1976).

A method for the mathematical determination of the magnitude of the thermal stresses arising in coke during its wet and dry quenching is given. Using the coke of the Novolipetsk metallurgical factory as an example, a calculation has been made of thermal stresses and the conditions of breakdown of lumps of different strengths in both methods of quenching have been determined. With NLMZ coke as an example, a calculation has been made of the thermal stresses arising in the cooling of the coke, and the conditions of breakdown of pieces of different strength on wet and dry quenching have been determined. 8 refs.

40828 Estimation of the reducing properties of ferrocoke as a carbonaceous reducing agent in the smelting of ferroalloys. Mizin, V.G.; Prilepskaya, L.L.; Iskhakov, Kh.A.; Syskov, K.I.; Serov, G.V. (Sci-Res Inst of Metall, USSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 1, 54-58(1976).

In the reported experiments, the physicochemical properties of cokes with additions of ferruginous sludge and their reducing properties with respect to silica have been studied. On the basis of the results of x-ray structural analysis and kinetic curves, a complex influence of the addition of iron both on the crystalline structure of the cokes and on their interaction with silica has been shown. Experimental data are presented which show that higher rates of carbide-formation and lower losses of silicon in the volatile matter using the experimental cokes permit ferrocoke to be regarded as a promising carbonaceous reducing agent in the smelting of, in particular, silicon-containing ferroalloys. The favorable reducing properties of ferrocokes with respect to silica are predetermined by the complex combined influence of iron on the crystal structure of the cokes and on their interaction with silica. At the temperature of reduction processes (1600-1800°C), additions of iron have a direct positive influence on the reaction of the carbon of the cokes with the silica. 14 refs.

40829 Investigation of some physicochemical processes in pitch-coke compositions. Lazarev, V.D.; Yanko, E.A. (All-Union Sci-Res and Des Inst of the Alum, Magnesium, and Electrode Ind, Irkutsk, USSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 1, 62-65(1976).

In the reported experiments, the specific surface, the adsorption, the wettability, and the reactivity of electrode powders have been investigated. Using experimental batches of electrode paste, the influence of the fractional composition of the coke filler on the mechanism of the destruction of the anode has been shown. It has been established that with an increase in the amount of the minus 0.05 mm class the degradability of fired samples of electrode rises substantially. 5 refs.

40830 Investigation of the organomineral compounds of brown coals by the ESR method. Aleksandrov, I.V.; Orlov, V.V.; Kamneva, A.I. (Mendeleev Moscow Inst of Chem Technol, USSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 1, 66-69(1976).

In the reported experiments, the humic acids, sodium humates, and preparations of water-soluble organomineral compounds of brown coals have been investigated by the ESR method. In alkaline solutions of the organic matter of fractions of the organomineral compounds, two types of radicals have been found that form donor-acceptor pair, one of which gives a single line analogous to that present in the initial coal and another a line with a hyperfine structure due to the interaction of an unshared electron both with protons and with nitrogen atoms. It has been found that these radicals undergo changes both with time and with a change in the pH of the solution. A hypothesis has been put forward on the inducing action of the radical products of the water-soluble compounds on the autoxidation of brown coal. 6 refs.

40831 Chemical reactions of the paramagnetic centers of coal pitch and the products of the hydrogenation of coals. Davydova, Zh.A.; Nedoshivin, Yu.N.; Sukhov, V.A.; Skripchenko, G.V.; Lukovnikov, A.F. (Inst of Combust Miner, USSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 1, 82-86(1976).

Results of a research program are presented which show that the paramagnetic centers of soluble products of coal origin are reactive centers and, depending on the conditions, take part in various chemical reactions: with free radicals, with saturated bonds, and with atomic hydrogen. Extensive experimental data are included. 7 refs.

40832 Laws of the distribution of normal and isoprenoid alkanes in coals of different ranks. Gulyaeva, N.D.; Aref'ev, O.A.; Sokolov, V.L.; Petrov, Al.A. (Inst of the Geol and Min of Combust Miner, USSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 1, 87-91(1976).

The problem of the origin of caustobioliths is directly connected with questions of the formation of and the search for deposits of coal, petroleum, and natural gas and is therefore of great theoretical and practical interest. The solution to this problem is impossible without a knowledge of the structure of the components of the caustobioliths, a study of the hydrocarbon components is of particular value: their composition and structure probably depend on the initial material and the pathways of its transformation. Of particular interest for genetic comparisons is the determination in the composition of caustobioliths of inherited (relict) structures. In the reported investigation, the hydrocarbons of the series of normal and isoprenoid alkanes in coals of the gelitolite class of different ranks has been studied. The results of the investigation performed show that the laws of the distribution of the normal and isoprenoid alkanes are determined by the degree of transformation of the organic matter in the metamorphic process. The distribution of n-alkanes in brown coals has the form of a two-humped curve with a marked fall in the concentrations of normal C_{19}-C_{24} paraffins, while for hard coals maximum concentrations of these paraffins are characteristic. A more uniform distribution of the isoprenoid hydrocarbons than for hard coals is characteristic for brown coals. 10 refs.

40833 Kinetics of the reaction of a coal-graphite material with oxygen. Katelyanov, B.Ya. (Dnepropetrovsk Metall Inst, Ukr SSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 1, 105-107(1976).

Results of an investigation are presented which was carried out in order to study the kinetics of the reaction of a coal-graphite material with oxygen in the temperature range from 293 to 2173 K. It is demonstrated that the dependence of the rate of the reaction of carbonaceous materials with oxygen on the temperature has falls and rises over the whole temperature range studied. In view of the fact that the activity of oxygen increases continuously with a rise in the temperature, a tentative explanation of this phenomenon can be expressed in the following way. With a change in the temperature conditions, the carbon atoms change the energy of the bond between the individual atoms of the structural sections through the passage of electrons into new orbitals. This leads to a change in their activity in interaction with other elements. 4 refs.

40834 Coal I: current advances in coal chemistry and mining techniques. New York; MSS Information Corporation (1976). 206p.

Eleven articles from the book, "Coal I: Current Advances in Coal Chemistry and Mining Techniques", have been entered into EDB and ERA. A twelfth article, " Detonations in Suspensions of Coal Dust in Oxygen", by M. A. Nettleton and R. Stirling has been entered previously from another source as item 76:09164. The articles cover in-situ gasification, coal reserves, analytical methods for sulfur and ten trace elements, optical properties of vitrinites after various degrees of carbonization, changes in the micropore structure at various degrees of carbonization, and two papers on correlations. (LTN)

40835 Use of a flame photometric detector for the analysis of coal sulfur. Dariage, L.J.; Block, S.S.; Weidner, J.P. pp 69-76 of In Coal I: current advances in coal chemistry and mining techniques. New York; MSS Information Corporation (1976).

The response of a flame photometric detector to the sulfur oxides produced by the combustion of sulfur-containing coal samples in a modified oxygen-flask is investigated, and a linear sulfur mass-response relationship is obtained. This method as applied to eight different coals is shown to be a simple, rapid, and reasonably quantitative procedure for the analysis of coal sulfur. It is also utilized on a qualitative basis for detecting organo-sulfur compounds in preparative TLC separations.

40836 Novel wet-digestion procedure for trace-metal analysis of coal by atomic absorption. Hartstein, A.M.; Freedman, R.W.; Platter, D.W. pp 78-84 of In Coal I: current advances in coal chemistry and mining techniques. New York; MSS Information Corporation (1976).

The procedure detailed permits the rapid and reliable quantitative determination of beryllium, cadmium, calcium, cobalt, copper, lithium, potassium, magnesium, manganese, and nickel in coal at sample weights as low as 10 mg. This method may be amenable to the analysis of other elements in coal because all metals present are in solution. The combination of fuming nitric acid, hydrofluoric acid, and boric acid has been found to be an excellent medium for oxidation and solvation of coal, and in addition provides a suitable matrix for subsequent analysis by atomic absorption spectrophotometry.

40837 Optical properties of carbonized preoxidized vitrinites. Goodarzi, F.; Murchison, D.G. pp 86-94 of In Coal I: current advances in coal chemistry and mining techniques. New York; MSS Information Corporation (1976).

The optical properties of 546 nm of three vitrinites (daf carbon contents 82.5, 88.0 and 93.1%) have been examined after pre-oxidation for 14 days at 105°C and carbonization at intervals of 50°C within the temperature range 300-800°C. In general, pre-oxidation prior to carbonization produces only relatively small changes in the trends of optical parameters with temperatures that were observed for the same vitrinites when carbonized fresh; the properties of the anthracitic vitrinite displayed little modification. Reflectivities of carbonized pre-oxidized vitrinites of bituminous rank are higher than those for the equivalent fresh vitrinites up to 500°C, supporting the suggestion that oxidation raises aromaticity and consequently the reflectivity. The most noticeable optical difference occurs with the bituminous-rank vitrinites, in the variation with carbonization temperature of their refractive-index curves, which parallel the behavior of the L/sub c/ curves of X-ray diffraction studies. In particular, the refractive-index track for the carbonized pre-oxidized vitrinite of coking-coal rank no longer shows the same marked contrast to the refractive-index tracks of vitrinites of higher and lower rank, as it does at temperatures above 600°C when carbonized fresh. The absorptive indices follow similar trends to the reflectivities for all the chars.

40838 Study by density measurement of changes in pore structures of coals with heat treatment. II. Micropore structure. Toda, Y. pp 95-107 of In Coal I: current advances in coal chemistry and mining techniques. New York; MSS Information Corporation (1976).

Changes in micropore structures of six Japanese coals during heat treatment up to 1200°C were followed by measured densities in n-hexane, in methanol and in helium. The micropore volumes were deduced from the difference between the reciprocals of the densities in n-hexane and in methanol. The concept of the crystallite was used in discussing the micropore structures of carbonized coals. Changes in the micropore structures were explained in terms of evolution of gases, change in the orientation of graphite-like layers, shrinkage of the structure, and so on. The different variations in micropore structures with heat treatment, between lower-rank coals and higher-rank coals, could well be accounted for by classifying the lower-rank coals and the higher-rank coals as nongraphitizing carbon and graphitizing carbon, respectively. It is suggested that for coals and their carbonized products the entrance diameters of the micropores located between the crystallites are smaller than the diameter of n-hexane molecules.

40839 Oxidized vitrinites: their aromaticity, optical properties, and possible detection. Goodarzi, F.; Murchison, D.G. pp 123-129 of

In Coal I: current advances in coal chemistry and mining techniques. New York; MSS Information Corporation (1976).

The behavior of the dispersion curves of refractive and absorptive index of a vitrinite of high-volatile rank oxidized for different periods of time up to 128 days at 105°C supports the suggestion that the aromaticity and/or condensation of the vitrinite rise when it is oxidized. Equivocal optical data previously obtained for oxidized vitrinites can probably be explained by the extensive use in earlier microscopical studies of wavelengths in the green region of the visible spectrum. Reflectivity-dispersion data indicate that there is greater possibility of distinguishing oxidized and weathered coals from fresh samples with the microscope by comparing their optical properties in the blue region of the visible spectrum or in the ultraviolet.

40840 Optical roperties of carbonized vitrinites. Goodarzi, F.; Murchison, D.G. pp 130-146 of In Coal I: current advances in coal chemistry and mining techniques. New York; MSS Information Corporation (1976).

The optical properties have been examined of three vitrinite-rich coals (carbon, daf: 82.5, 88.0 and 93.1 percent), carbonized at temperature intervals of 25°C over the greater part of the range 20-950°C using a heating rate of 2.45°C/min. The small temperature interval employed has allowed a satisfactory correlation between alterations in the physical state of the carbonized products and fluctuations in the rates of change of their optical properties during carbonization. In general, as temperature rises the variation of all the optical properties reflects the growth and development of organized polycondensed aromatic systems, but in detail reflectivity does not prove as sensitive an indicator of structural changes as do other optical parameters, particularly refractive index. The behaviour of the refractive-index curves of the carbonized vitrinites is governed by changes in the heights of the crystallites forming the aromatic systems. The shape of these curves closely follows the shape of curves produced in independent X-ray diffraction studies giving the heights of crystallites. While all the refractive-index and all the absorptive-index curves are similar in shape and trend to one another, each of these curves for carbonized coking-coal vitrinite is displaced from the equivalent curves for low-rank bituminous and anthracitic vitrinites. The displacement can be related to the formation of the highly-plastic stage during carbonization of the coking-coal vitrinite, which ultimately yields weakly cross-linked structures with good crystallite orientation, in contrast to the strongly cross-linked structures with lower ordering developed in carbonization of vitrinites of both lower and higher rank.

40841 Estimation of some properties of South African coals from proximate analyses. de Kock, J.W.; Franzidis, J.P. pp 147-160 of In Coal I: current advances in coal chemistry and mining techniques. New York; MSS Information Corporation (1976).

Correlations have been obtained whereby calorific values, ultimate analyses, and Hardgrove indices can be estimated from proximate analyses of South African coals. This has been done by the application of stepwise multiple linear-regression analyses of a mass of data published by the Fuel Research Institute.

40842 Catalysts for the depolymerization of mature coals. Ouchi, K.; Imuta, K.; Yamashita, Y. pp 49-51 of In Coal processing. New York; MSS Information Corporation (1976).

The depolymerization reaction is an attractive method for structural studies of coal. Since strong acids are sometimes effective catalysts in this type of depolymerization reaction, we have examined various inorganic and organic acids, two sodium salts, and also some Friedel—Crafts catalysts. The effectiveness of the catalysts was measured by increases in the weight extracted by pyridine and benzene-ethanol extractants.

40843 Adhesion of micron sized coal particles to a massive coal substrate. McClure, J.C. Jr.; Keller, D.V. Jr. pp 52-62 of In Coal processing. New York; MSS Information Corporation (1976).

This investigation demonstrated that the force of adhesion between 2 to 5 μm coal particles and a coal substrate can be measured with an ultracentrifuge. Repeated tests under identical experimental conditions show that the force can be measured to an accuracy of about +- 8 percent. The data indicate that neither the orientation of the substrate surface with respect to its bedding planes nor an initial positive charge of several hundred elementary units significantly affects the force of adhesion. However, the force of adhesion on cleaved substrates is about 40 percent higher than on those which were mechanically polished. The force needed to remove 50 percent of the particles was about 2 millidynes.

40844 Reactions of coal with nitrogen/hydrogen mixtures in a discharge. Nishida, S.; Berkowitz, N. pp 77-83 of In Coal processing. New York; MSS Information Corporation (1976).

In-discharge reaction of coal with nitrogen/hydrogen mixtures rather than nitrogen alone raises rates of hydrogen cyanide generation by a factor of 10-50, and makes hydrogen cyanide account for approximately 70 to 90 percent of the total product-gas volume. From these results and parallel tests with a pure carbon, it is concluded that enhanced formation of hydrogen cyanide is controlled by transient hydrogenation of aromatic carbon and consequent creation of additional (non-aromatic) reaction centres which can be abstracted by excited nitrogen.

40845 Reactions of coal with discharge-generated (excited) nitrogen species. Nishida, S.; Berkowitz, N. pp 84-96 of In Coal processing. New York; MSS Information Corporation (1976).

Reaction between coal and nitrogen in a discharge furnishes hydrogen cyanide and smaller amounts of cyanogen, as well as some carbon monoxide and carbon dioxide; the cumulative yields of hydrogen cyanide and cyanogen depend upon rank. The apparent activation energies for formation of hydrogen cyanide and cyanogen are in the order of 2 to 4 kcal mol^{-1} but increase sharply to approximately 13 to 14 kcal mol^{-1} at approximately 200°C (possibly coincident with incipient thermal decomposition of the coal). The cyanogen/hydrogen cyanide ratio increases with rank, and also depends upon the reaction temperature-falling with increasing temperature up to approximately 200°C, and thereafter rising progressively. Rate measurements and i.r. spectral changes accompanying the reaction suggest that hydrogen cyanide is mainly formed from non-aromatic carbon-hydrogen configurations in the coal, and that cyanogen derives for the most part from aromatic carbon—though some can also be generated from non-aromatic is identical with CH in competition with formation of hydrogen cyanide.

40846 Studies of the emission of elemental nitrogen from coals of different rank and its release under geochemical conditions. Klein, J.; Juentgen, H. pp 107-116 of In Coal processing. New York; MSS Information Corporation (1976).

Pyrolysis tests are described during which the release of elemental nitrogen from hard coals of different ranks was measured with a heating rate of 1°/min. The differential degasification curves of the nitrogen show: 20 to 50 percent of the total nitrogen are separated, in elemental form, at a heating of coal to 1,000°C depending on the type of coal (anthracite to high-volatile coal); and two gas formation maxima develop at about 700°C and at more than 1,000°C, which mean that the nitrogen in the coals is held in two energetically different types of bonding. By comparison with the separation of N_2 from model substances, the first maximum could be allocated to the decomposition of aliphatic nitrogen compounds and the second maximum to that of heterocyclic nitrogen compounds. The aliphatically bonded nitrogen in the coals decreases with increasing rank and the heterocyclically bonded nitrogen increases slightly. The reaction parameters activation energy E and frequency factor K_o of the N_2 release, calculated from the degasification curves, get smaller with decreasing rank. When these factors are known, T/sub M/ as a function of the heating rate can be calculated from the shifting of the temperature level of the degasification maxima, and for heating conditions that corresponds to the process of coalification from geological knowledge. The extrapolation to the heating rate of sinking-down earth blocks (for the Ruhr Carboniferous about 10^{-11} °/min) permits the conclusion that nitrogen, in elemental form, separated during the geothermal phase of coalification.

40847 Compound isolation from brown coal by low-temperature evacuation. Swann, P.D.; Harris, J.A.; Siemon, S.R.; Evans, D.G. pp 10-13 of In Extraction of useful chemical derivatives from coal. New York; MSS Information Corporation (1976).

The low-temperature oxidation of brown coal has been studied because of its importance in ignition, spontaneous combustion, and weathering properties, and because studies of brown-coal oxidation are few, relative to those of black-coal oxidation. The rate and extent of brown-coal oxidation has been shown to be far greater than that of black-coal oxidation. Bed-moist coal will not oxidize; consequently, the water must be removed from the coal before oxidation is performed. Considerable controversy exists concerning the state of the water in the coal. The work done by Allardice and Evans on the brown-coal/water system employing vacuum desorption of water clarifies the situation. They found that 'at least two classes of water exist in Yallourn brown coal at any particular temperature, firstly water which can be removed by evacuation at that temperature and secondly chemisorbed water which can be released only by raising the temperature to cause thermal decomposition of functional groups'. 'Above 60 degrees C significant quantities of carbon dioxide are also released from the evacuated coal.' Experimental results showed that the amount of oxidation, as measured by the weight increase of the coal, was affected by the degree of drying.

40848 Active radicals containing oxygen and caking property of lignite. Nomura, S. pp 183-187 of In Extraction of useful chemical derivatives from coal. New York; MSS Information Corporation (1976).

Differences in the caking power of lignite were observed, depending on whether hydrogen ions or sodium ions were absorbed on the surface. (LTN)

40849 **Electrical conductivity of coal slag.** Frederikse, H.P.R.; Hosler, W.R. pp 36-41 of In Coal processing. New York; MSS Information Corporation (1976).

The electrical conductivity of natural and synthetic slags (containing 14 to 36 wt percent Fe) was measured from 1200 to 1700°K at O_2 pressures from 1 to 2 x 10^{-6} atm. The conductivity is relatively high (approximately 10^{-3} Ω^{-1} cm^{-1} at 1700°K) and stems from the transfer of electrons between Fe^{2+} and $Fe^{3}+$ ions. Anomalies in the conductivity around 1600°K are the result of devitrification of the glass samples.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 40870, 40904

40850 (PB—254815) **Technology for using sulfate waste in highway construction. Final report.** Smith, L.M.; Kawam, A.; Whitcraft, M.S.; Larew, H.G.; McCormick, F. (Gillette Research Inst., Inc., Rockville, Md. (USA)). Dec 1975. Contract DOT-FH-11-8122. 212p. NTIS $7.75.

Mixtures of fly ash, lime and sulfate waste were examined for their potential use in highway construction. During this initial phase of the project, variables such as fly ash source, form of calcium sulfate, lime type, mixture consistency, curing temperature, admixtures and impurities expected in waste sulfates were examined. Also, studies of compound development in selected mixtures were performed. The second phase of the study was designed to obtain strength-compositional relationships for samples prepared with actual waste sulfates. These waste sulfates included neutralized acid mine drainage, titangypsum, hydrofluoric acid by-product, gas scrubber waste and neutralized steel pickling liquor. Results of this phase were used for the selection of mixtures for engineering evaluation. These mixtures were examined for compressive and tensile strength, freeze/thaw resistance, wet/dry stability, California bearing ratio, permeability and leachability.

40851 **Shell flue gas desulfurization process: demonstration on oil- and coal-fired boilers.** Groenendaal, W.; Naber, J.E.; Pohlenz, J.B. pp 106-135 of In Petroleum derivatives. II. Current research. New York; MSS Information Corporation (1976).

The process is based on the reactivity of SO_2 with CuO. In-situ CuO regeneration is carried out at the same temperature as SO_2 capture yielding SO_2-rich off-gas which can be processed to elemental S in a Claus unit. The process was tested at Shell's refinery at Pernis, Netherlands, and in a coal-fired boiler at Rotterdam. (JRD)

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 40753, 40870, 40871, 41951, 41958, 41983, 42118, 42119, 42120, 42121, 42124, 42125

40852 (ANL—76-XX-42) **Land Reclamation Program. Annual report, July 1975—July 1976.** (Argonne National Lab., Ill. (USA)). Dec 1976. Contract W-31-109-ENG-38. 47p. Dep. NTIS, PC A03/MF A01.

The Land Reclamation Program was initiated at Argonne National Lab. in June, 1975, to address the need for coordinated applied and basic research into the environmental problems associated with utilization of coal, one of the nation's most abundant energy forms. It is anticipated that the current national coal production of 648 million tons will double by 2000. The major share of this projected increase is expected to be from surface mines, especially because surface mining is more economically advantageous than deep mining. However, surface mining of coal is more disruptive environmentally, and has greater potential to destroy existing ecosystems, impact water quality, and alter land usage. There is, therefore, a great need to better understand and evaluate the feasibility, costs, and potential effectiveness of alternative reclamation technologies as applied to surface mining. Integrated methods to reclaim surface-mined land in the U.S. have only been recently undertaken, and their effectiveness is either undetermined or poorly understood and not known over a long-term period. A well-structured, long-range nationally coordinated program is needed to develop, test, and deploy the most cost-effective techniques and technologies for land reclamation that are currently available. The goal of the Land Reclamation Program is therefore to conduct coordinated field and laboratory R and D programs focused on near- and long-term land reclamation problems and land use in the four major U.S. coal-resource regions.

40853 (E—76-10445) **Contribution of ERTS-B to natural resource protection and recreational development in West Virginia. Progress report No. 3, 19 Mar—19 Jun 76.** Latimer, I.S. Jr. (West Virginia Dept. of Natural Resources, Charleston (USA)). 19 Jun 1976. 22p. NTIS $3.50.

No abstract available. (GRA)

40854 (MERC/SP—76/3, pp 105-118) **Groundwater contamination from in-situ coal gasification: laboratory studies.** Henry, J.F.; McKinley, M.D. 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

A feasibility study for in-situ coal gasification in the Warrior coal field of Alabama is being conducted. As part of this study, estimates of the effect of a coal gasification operation on the groundwater are being made. The levels of contaminants to be expected by leaching of chemicals from burned-out coal seams by groundwater flowing through the area were predicted by experimental simulation in the laboratory. In most cases the levels of contaminants never exceeded the recommended limits for public water supplies. In those cases where the level of contaminants in the water was initially high, the concentration rapidly decreased so that no long term problems are predicted.

40855 (MERC/SP—76/3, pp 140-144) **Hydrogeologic assessment of an underground coal gasification project site Grant District, Wettzel County, W. Va.** Sole, T.L.; Byrer, C.W. 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

This hydrogeologic investigation provides baseline data on water quality and aquifer properties for the area surrounding the underground coal gasification site near Princetown, West Virginia. Stratigraphic and domestic water well studies show that most wells are in shale aquifers of the Middle Dunkard Group; these wells yield about 1 to 8 gallons per minute of relatively good-quality water, except for excessive dissolved iron, manganese, arsenic, and lead in some wells. Moderate to low permeabilities of 0.032 to 0.18 millidarcys and transmissivities of 268 to 1003 gallons per day per foot were measured for shallow aquifers. Aquifer permeability and well productivity are significantly higher for wells within 35 feet of mapped fracture traces.

40856 (PB—254924) **A comparative case study of the impact of coal development on the way of life of people in the coal areas of eastern Montana and northeastern Wyoming. Final report.** Gold, R.L. (Montana Univ., Missoula (USA). Inst. for Social Science Research). 30 Jun 1974. 312p. NTIS $9.75.

The report contains a description and analysis of the social impact which the development of the nation's coal resources in the Northern Great Plains is having on the way of life of people living in selected coal areas of eastern Montana and northeastern Wyoming. Appendix A is an essay on the ethnographic method of research used for this study. The study describes what the changes brought about by coal-related development mean to the pre-development residents of these rural areas.

40857 (PB—255298) **Evaluation of surface mine reclamation techniques. Campbell's Run Watershed, Pennsylvania. Final report, Nov 1970—Oct 1975.** Dougherty, M.T.; Holzen, H.H. (Pennsylvania Dept. of Environmental Resources, Harrisburg (USA)). Jun 1976. 61p. NTIS $4.50.

Prepared in cooperation with Ackenheil and Associates Geo Systems, Inc., Pittsburgh, Pa.

A study was performed to demonstrate the effectiveness of surface reclamation of strip mined land upon water quality in streams receiving mine drainage pollution from abandoned underground mines. The water quality was monitored in three phases, prior to the surface reclamation, during reclamation, and after reclamation. The results were then evaluated to determine any improvement in water quality resulting from the construction of the abatement facilities. (GRA)

40858 (PB—258041-SET/SL) **Development of pre-mining and reclamation plan rationale for surface coal mines.** (Dames and Moore, Denver, Colo. (USA)). 1976. 590-in 3vp. NTIS $20.50.

Set includes PB—258042 thru PB—258044.

40859 (PB—258042) **Development of pre-mining and reclamation plan rationale for surface coal mines. Volume I. The rationale for data acquisition. Final report.** (Dames and Moore, Denver, Colo. (USA)). Jun 1976. Contract J0255002. 163p. NTIS $6.75.

This report develops a comprehensive, coordinated approach to site data-acquisition activities to produce key plans and reports during the evaluation and development of a surface coal mine. A logic diagram illustrates activities in the planning and decision-making process from exploration through post-mining monitoring. The report briefly discusses major elements, other than the site environment, which influence development of mining and reclama-

tion plans and refers to other readily available literature for details outside the scope of this study. (GRA)

40860 (PB—258043) **Development of pre-mining and reclamation plan rationale for surface coal mines. Volume II. Methods of data acquisition. Final report.** (Dames and Moore, Denver, Colo. (USA)). Jun 1976. Contract J0255002. 175p. NTIS $6.75.

Volume II, in conjunction with Volume I, is a general guide to the selection of cost-effective methods of site data acquisition in all geologic, environmental, and socio-political circumstances. The judgement of a generalist or trained specialist must be relied upon in the final analysis to design the optimum program for a specific site.

40861 (PB—258044) **Development of pre-mining and reclamation plan rationale for surface coal mines. Volume III. Legal controls of surface mining. Final report.** (Dames and Moore, Denver, Colo. (USA)). Jun 1976. Contract J0255002. 252p. NTIS $9.00.

This report provides a concise review of six major types of legal constraints, controls, and regulations on surface coal mining in the United States, as of January 1976. At the same time, an attempt is made to format the details of Federal and State exploration, mining, and reclamation regulations such that point-by-point comparisons can be made and updated as revisions occur.

40862 (UCD—472-123, pp 122-124) **Health effects of pollutants associated with fossil-fuel power generation.** Azevedo, J.W.; Berding, K.L.; Book, S.A. (National Technical Information Office, Springfield, VA). 1976.

In Annual report, fiscal year 1976.

An indexed bibliography with abstracts, including references from 1921 to 1975 (Azevedo et al., UCD 472-500, 1976) was prepared as part of a risk assessment program designed to evaluate the health hazards associated with pollutants generated during fossil-fuel electric power generation. The 585 articles selected for inclusion in this bibliography were those with data on the metabolism and health effects of air pollutants on humans and other animals. Another criterion for inclusion in the bibliography was the association of exposure level with a specified effect.

40863 **Environmental impact of open pit mining in the conclusions of 'bergbau '76'.** Schmidt, G. *Glueckauf:* **112**: No. 18, 1085-1086(Sep 1976). (In German with English abstract).

Water resources protection reports from various countries and air and soil pollution control measures are discussed. A device for pyrite separation from coal shown at the Exposition is described. 3 refs.

RESERVES AND EXPLORATION

40864 **Sedimentary structures and paleocurrents in a tertiary deltaic succession, Northern Banks Basin, Arctic Canada.** Miall, A.D. (Geol Surv of Can, Calgary, Alberta). *Can. J. Earth Sci.;* **13**: No. 10, 1422-1432(Oct 1976).

The Eureka Sound Formation of northern Banks Basin is a deltaic unit of Paleocene to Eocene age. A basal member of shale, approximately 100 m thick, passes vertically and, in part, laterally into a succession of sand, silt, shale, and lignitic coal approximately 1000 m thick, which is referred to as the cyclic member because of the abundance of coarsening-upward cycles, averaging 7.4 m in thickness. Paleocurrent data suggest a pattern of radiating distributaries within each delta lobe. Directional variance, when analyzed at various levels of the sedimentary structure hierarchy, provides information regarding channel sinuosity and enables comparisons to be made with other deltaic deposits. High variance for the directions of the distributaries is consistent with a fluvially dominated delta. 33 refs.

40865 **Nature and distribution of self-potential in worked coal seams.** Tarasov, B.G.; Krol', G.V.; Dyrdin, V.V.; Ivanov, V.V. (KuzPI, Kemerovo, USSR). *Sov. Min. Sci. (Engl. Transl.);* **11**: No. 6, 734-738(1975).

Redox SP and pH of pit waters, coals, and country rocks are determined in nitrogen atmosphere. Laboratory and field measurements of the electrode potential differences of the coal, roof, and floor lead to the conclusion that the main cause of the natural electric field is the difference between the redox SP of the coal, the country rock, and the underground waters, and also their variation with depth. 16 refs.

40866 **Geological and mining conditions of coal deposits in safety pillars in the Upper Silesian coalfield.** Szwedzicka, M. *Przegl. Gorn.;* **32**: No. 7-8, 308-312(1976). (In Polish with English summary).

Tectonics and structure of coal field are described, and analysis of statistical material with the view of systematization of mining and geological conditions of deposits contained within pillars is presented. 3 refs.

40867 **Geomathematical prediction of sulphur in coal, New Lingan Mine area, Sydney coalfield.** Agterberg, F.P.; Chung, C.F. pp 38-68 of In Coal I: current advances in coal chemistry and mining techniques. New York; MSS Information Corporation (1976).

Prediction of a variable sulphur content in Cape Breton seams is important for planning the production of a high-grade metallurgical coal. Two extrapolation methods (Kriging and a version of Universal Kriging) to predict sulphur content in blocks of coal before mining are presented and applied to the New Lingan Mine reserves in the Harbour seam. The uncertainty of the predicted values is expressed by standard deviations. Some statistical results for the Phalen seam, which occurs about 400 ft below the Harbour seam, are presented for comparison. The two mathematical models consist of two sets of equations which have been used in computer algorithms. Some limitations of the present approach and possibilities for further statistical work are indicated.

40868 **Coal resources for the fertilizer plant at Korba, Madhya Pradesh.** Shah, B.L.; Bhaduri, A.K.; Datta, K.K.; Deshmukh, B.S. pp 110-122 of In Coal I: current advances in coal chemistry and mining techniques. New York; MSS Information Corporation (1976).

The Korba fertilizer plant envisages the use of coals from the Banki-Surakachhar collieries, Korba coalfield for the production synthesis gas. The coal reserves and production potential at the two collieries are adequate to meet the requisite demand of 0.835 m. tonnes of coal/year. A wide range of data on the general characteristics of these coals are available from borehole records and the analysis of samples collected periodically from the two collieries. It is hoped that this information will prove useful in planning the use of these coal resources for the proposed fertilizer plant.

MINING

REFER ALSO TO CITATION(S) 40785, 40816, 40852, 41642

40869 (E—76-10419) **Application of EREP imagery to fracture-related mine safety hazards in coal mining and mining-environmental problems in Indiana. Final report Apr 73—Apr 75.** Wier, C.E.; Powell, R.L.; Amato, R.V.; Russell, O.R.; Martin, K.R. (Indiana Geological Survey, Bloomington (USA)). Oct 1975. Contract NAS9-13358. 58p. NTIS $4.50.

Prepared in cooperation with Earth Satellite Corp., Washington, D.C.

The author has identified the following significant results. This investigation evaluated the applicability of a variety of sensor types, formats, and resolution capabilities to the study of both fuel and nonfuel mined lands. The image reinforcement provided by stereo viewing of the EREP images proved useful for identifying lineaments and for mined lands mapping. Skylab S190B color and color infrared transparencies were the most useful EREP imagery. New information on lineament and fracture patterns in the bedrock of Indiana and Illinois extracted from analysis of the Skylab imagery has contributed to furthering the geological understanding of this portion of the Illinois basin. (GRA)

40870 (NTIS/PS—77/0040) **Coal mine waste (a bibliography with abstracts). Report for 1964—Nov 1976.** Smith, M.F. (National Technical Information Service, Springfield, Va. (USA)). Feb 1977. 104p. NTIS, PC N01/MF A01.

Supersedes NTIS/PS—75/112 and NTIS/PS—76/0053.

Research topics cover coal mining refuse, refuse dumps and spoil. Studies on disposal, utilization, environmental impacts and testing of these wastes are included, as are reports on land reclamation and spoil bank safety. (This updated bibliography contains 99 abstracts, 23 of which are new entries to the previous edition.)

40871 (ORO—4946-2) **Environmental aspects of coal production in the Appalachian Region. Progress report, June 1, 1976—May 31, 1977.** Minear, R.A.; Tschantz, B.A.; Rule, J.H.; Vaughan, G.L.; Overton, D.E.; Briggs, G. (Tennessee Univ., Knoxville (USA). Appalachian Resources Project). 1977. Contract EY-76-S-05-4946. 95p. Dep. NTIS, PC A05/MF A01.

The overall project focus is on damage agent flows resulting from strip mining: To fully identify specific damage agents released during the mining process, quantify them, describe their origin and method of transport and to assess their effects: Biological, chemical and physical. The common time and location of study for the individual research tasks allows an economy of data acquisition and exchange not possible through sequential task performance and, even more importantly with field research, all observations have a commonality of climatological, geological and physical variables. While restricted initially to field work in the mining areas of eastern Tennessee, models developed and phenomena observed will be tested for generalization and regional application as a part of the long-term goals. Significant achievements have been made toward characterizing and quantifying the environmental effects of coal

surface mining because the data base has evolved sufficiently to allow evaluation of effects and to begin preliminary model development. These models are necessarily preliminary, however, because adequate validation of such models requires many years of observations before reliability can be fully assessed. The major realization of the past year is the interrelation of the task areas in the sense of each task being able to employ results from the others in satisfaction of the overall project objectives. Major implications are beginning to be observed that are relative to proposed mining operation procedures and associated regulatory activities. The full definition of these implications continues to be the primary overall objective of project activities in the coming year. Individual task results that follow provide specific detail.

40872 (PB—254301) **Study of low coal canopy concepts. Final Report, 17 Jun 1974—20 Feb 1975.** Billmayer, H. (Bendix Corp., Denver, Colo. (USA). Guidance Systems Div.). Feb 1975. Contract H0346102. 42p. NTIS $4.00.

The objective of this contract was to develop protective canopy concepts for low coal machines. The four machines specifically addressed in this study were the Wilcox Mark 20 PJ Auger Miner, the Wilcox Roof Bolter ('J'), the Lee-Norse 245L Continuous Miner, and the Elkhorn AR-4 Scoop. Protective canopy concepts were designed for each machine. Wooden mockups of the canopy concepts were constructed. These mockups were installed on the machines and were evaluated in the mine by the machine operators and mine foreman. (GRA)

40873 (PB—254504) **Development of protective canopy concepts for underground rail haulage equipment. Research report.** Billmayer, H.J. (Bendix Corp., Ann Arbor, Mich. (USA). Energy, Environment, and Technology Office). 12 Jan 1976. Contract DI-H0357091. 114p. NTIS $5.50.

The contractor developed protective canopy designs for rail haulage equipment. Canopy concepts were developed for three classes of rail haulage equipment, mainline haulage locomotive, secondary haulage locomotive, and small utility vehicles. Protective canopy concepts were developed for four particular machines. These were a GE-LME-2C, 50-ton locomotive; a GE-LME-2C209, 20-ton locomotive; a GE-LM-2010-B1, 8-ton locomotive; and a Lee-Norse Mine Mechanics Jitney, TJ-122. Wooden mockups for two machines, the 50-ton locomotive and jitney, were constructed. They were installed on their respective machines and evaluated underground. (GRA)

40874 (PB—254575) **Preliminary engineering and economic evaluation of underspoil haulage in area strip coal mines. Part I. Summary report, 27 Jun—10 Oct 1975.** Gallegos, O.A. (Dravo Corp., Denver, Colo. (USA)). 10 Oct 1975. Contract J0155151. 121p. NTIS $5.50.

Underspoil haulage is defined as the transportation of coal from the pit-bottom by belt conveyor through a tunnel under the spoil. Tunnel structures capable of withstanding the physical forces anticipated were designed after the physical parameters were defined. The tunnel design incorporated construction techniques commonly used in the mining and construction industries. Appropriate provisions were made to provide a safe, comfortable working environment. High speed, high capacity conveyor belts were computer-designed to properly match the various production rates considered. Several methods of loading, crushing and transporting the coal from the working face to the underspoil conveyor were conceived and from these, four were selected for further analysis. Operating and capital cost estimates were prepared for the four systems. (GRA)

40875 (PB—254768) **Survey of equipment manufacturing research and development needs. Final report.** (Davis (J.J.) Associates, McLean, Va. (USA)). Dec 1975. Contract CO-05-50269-00. 176p. NTIS $7.50.

The report identifies constraints placed upon the manufacturers of coal production equipment in light of expected increases in equipment demand and the need for new technologies.

40876 (PB—254863) **Concept feasibility study for training equipment to improve coal productivity. Volume I. Final report.** Szczuka, A.E.; Contor, K.L.; Morris, C.W. (McDonnell Douglas Electronics Co., St. Charles, Mo. (USA)). 2 Apr 1976. Contract J0255014. 223p. (MDC-M—0019-Vol-1). NTIS $7.75.

See also Volume 2, PB—254864.

Two facets of surface mining were studied: feasibility of using training simulators to increase productivity of haulage trucks, front-end loaders, and shovels; and improving the efficiency of dragline operations with a computer-aided analysis of dragline usage and the addition of an on-board operator display. Training costs per student were estimated based on current training practices. Training objectives were derived from task analyses of haulage trucks, front-end loaders, and shovels. The cost effectiveness of training simulators was determined. A computer-aided analysis defined the critical performance parameters.

40877 (PB—254864) **Concept feasibility study for training equipment to improve coal productivity. Volume 2. Appendices. Final report.** Szczuka, A.E.; Contor, K.L.; Morris, C.W. (McDonnell Douglas Electronics Co., St. Charles, Mo. (USA)). 2 Apr 1976. Contract J0255014. 305p. (MDC-M—0019-Vol-2). NTIS $9.75.

See also Volume 1, PB—254863.

Two facets of surface mining were studied: feasibility of using training simulators to increase productivity of haulage trucks, front-end loaders, and shovels; and improving the efficiency of dragline operations with a computer-aided analysis of dragline usage and the addition of an on-board operator display. This report covers task analyses and objectives of the study.

40878 (PB—255944) **Bibliography on analysis and design of coal mine structures using finite element techniques.** Wang, S.T.; Blandford, G.E.; Galloway, L.M. (Kentucky Univ., Lexington (USA). Inst. for Mining and Minerals Research). Apr 1976. 96p. (IMMR—13-M1-76). NTIS $5.00.

This bibliography is the first part of the final report to the Institute for Mining and Minerals Research (IMMR) for a research project entitled Analysis and Design of Coal Mine Structures Using Finite Element Techniques. There are some 430 citations listed covering publications through mid-1975. The bibliography is divided into three sections: Reference Index, Keyword Index, and Author Index. The Reference Index is further divided into parts which contain listings dealing with references using the finite element method with applications to mining problems, especially coal mining; references related to finite element techniques (solution methods, pre- and post-processors); and references related to coal mining problems not using the finite element method. This document should be of interest and assistance to those who are engaged in research dealing with mining problems, especially coal mining problems. (GRA)

40879 (PB—258304) **Demonstration of coal mine haul road sediment control techniques. Final report.** Grier, W.F.; Miller, C.F.; Womach, J.D. (Kentucky Dept. for Natural Resources and Environmental Protection, Frankfort (USA)). Aug 1976. 84p. NTIS $5.00.

This Report examines the feasibility of demonstrating the most effective methods of controlling erosion which results when land is disturbed and altered by the construction of access roads to coal mining operations in the steeply sloping areas of Appalachia. The methods of controlling erosion on haul roads as examined herein are techniques that can reasonably and economically be constructed by conventional equipment that is normally used or is available to coal operators. A method to collect qualtitative data, by remote instrumentation, for evaluation of the effectiveness of the erosion control methods is also described. (GRA)

40880 (PB—262119) **Roof-fall resupport accidents, a study. Information Circular, 1976.** Stears, J.H.; Conway, J.P.; Bates, R.C. (Bureau of Mines, Spokane, Wash. (USA). Spokane Mining Research Center). Nov 1976. 100p. (BM-IC—8723). NTIS, PC A05/MF A01.

Approximately six lives a year are lost in underground coal mines while cleaning up roof falls and resupporting the roof. A study was conducted to obtain possible insight into the causes of resupport accidents and develop methods of reducing fatalities. Data from 47 coal mine roof-fall resupport accidents that resulted in 62 injuries or fatalities and occurred from 1966 through 1974 were compiled and analyzed to identify critical hazards and problems. Problem areas where present technology is inadequate and where additional work is needed were identified.

40881 (PB—262189) **Longwall gob degasification with surface ventilation boreholes above the lower Kittanning coalbed. Report of investigations.** Moore, T.D. Jr.; Deul, M.; Kissell, F.N. (Bureau of Mines, Pittsburgh, Pa. (USA). Pittsburgh Mining and Safety Research Center). Nov 1976. 19p. (BM-RI—8195). NTIS, PC A02/MF A01.

Methane emission from two surface gob-degasification boreholes was measured during mining of a 3,200-ft longwall panel in the Lower Kittanning coalbed in central Pennsylvania. The first hole was 500 feet, and the second hole was 2,200 feet from the start of mining. The first hole went on natural draft as soon as the longwall face passed it. This caused the methane flow in the return entries to drop 75%. In the six months required to complete the panel, the two holes produced 69 million cubic feet of methane in varying precentages of concentration in air. In 3 years, they produced a total of 150 million cubic feet of methane.

40882 **Comparative analysis of cutter and drill splitting mechanisms of mining machines.** Plotnikov, V.P. (Metal Inst, Novokuznetsk, USSR). *Sov. Min. Sci. (Engl. Transl.);* **11**: No. 6, 699-702(1975).

Cutters with annular chain bars and relative face cutting areas of various cutter heads are analyzed. It is concluded that the relative area of cutting of present cutting heads ranges from 50-60 to 15-17%, while the yield of fines exceeds 30% owing to additional crushing of the coal by auxiliary units and loaders, and all present narrow-cut cutter-loaders and static planers do not give better coal quality than cutting heads, because they produce over 30% of fines. Borehole

splitting auxiliary units can be highly productive and can give small amounts of fines, because their relative cutting area can vary between 1 and 8% for borehole diameters of 40-50 mm. 4 refs.

40883 Influence of vibration parameters on the process of advancing a shield-type support. Korshunov, A.N.; Aleksandrov, B.A.; Knurenko, V.A.; Fainer, I.A. (KuzPI, Kemerovo, USSR). *Sov. Min. Sci. (Engl. Transl.);* **11**: No. 6, 743-745(1975).

Large-scale model simulating the floor and the strata in the immediate main roof and the superincumbent roof strata, is used to determine the optimal vibration parameters and to elucidate their influence on the advancing of the shield. It is found that for all the investigated values the angle of dip of the seam, the smallest exciting force which initiates motion of the support corresponds to a vibration direction angle of 30-45°. 2 refs.

40884 Probabilities of states of a bunker in transient conditions. Shramko, V.M.; Golovanov, V.I. (A.A. Skochinskii Inst of Min, Lyubertsy, USSR). *Sov. Min. Sci. (Engl. Transl.);* **11**: No. 6, 767-770(1975).

A physical model of the problem of determining the probabilities of states of the bunker is random wandering of a particle over a region at the boundaries of which it undergoes delayed reflection. A mathematical model representing coefficients of coal volume dispersions is presented. 2 refs.

40885 Coal cutting with a disk. Korshunov, A.N.; Dergunov, D.M.; Logov, A.B.; Gerike, B.L. (Kuznets Polytech Inst, Kemerovo, USSR). *Sov. Min. Sci. (Engl. Transl.);* **11**: No. 5, 571-583(1975).

Results of an investigation to calculate the forces acting on a single disk cutter and to design the cutting head as a whole are presented. To investigate the cutting of coals with various mechanical properties disk cutters with various geometrical parameters and cutting parameters were used and the results were processed statistically. 5 refs.

40886 Transport of coal by shuttle trains at Dymitrow colliery. Motriuk, T.; Dabrowski, W. *Przegl. Gorn.;* **32**: No. 7-8, 301-305(1976). (In Polish with English summary).

The modernization of coal transport on production levels is discussed, namely: transition from small mine cars to self-dumping cars, associated with coal storage bunkers and with concurrent change of track gage, keeping the gage used until now in the material transport. The feasibility of extension of coal transport at Dymitrow colliery is presented and organizational, technical and economic effects resulting from the integrated solution of the problem are given.

40887 Automation of main wheel transport exemplified on Staszic colliery. Arkuszewski, J. *Przegl. Gorn.;* **32**: No. 7-8, 305-308(1976). (In Polish with English summary).

The first pilot solution of this system in Poland realized with the cooperation of the Swedish firm ASEA aims at a full utilization of the capacity of main transport facilities for ensuring the implementation of production assignments. Range of automation of the main transport and preliminary assessment of effects resulting from its application are discussed.

40888 Problem of safe undermining of seams in the light of practical experience gained in Nowy Wirek colliery. Wegrzyk, Z.; Krawiec, A. *Przegl. Gorn.;* **32**: No. 7-8, 313-318(1976). (In Polish with English summary).

It is shown that the ratio M 15 (i.e. the distance M between the seam in extraction and the overlying seam to the thickness of seam m) admitted according to the statutory guidelines for undermining the seams, is too high and calls for a correction. It is found that under the geological and mining conditions of the colliery the ratio of the distance between the seam in extraction and the overlying seam to the thickness of the seam worked with caving of roof or slice in this seam may be of 4 or more. 15 refs.

40889 Effect of mining on methane emission and concentration in return air. Marcol, J. *Przegl. Gorn.;* **32**: No. 7-8, 319-326(1976). (In Polish with English summary).

The influence of time of mining on the amount of methane emitted is analyzed. It is shown on the basis of measurements carried out that the concentration increases during mining and decreases during the stopping between the shifts. 16 refs.

40890 Design schemes of small diameter drillings in coal deposits. Grzes, M. (Osrodek Badaw-Rozwojowy Tech Geol, Pol). *Tech. Poszukiwan Geol.;* **15**: No. 3, 16-20(1976). (In Polish with English summary).

Data connected with casing design technological parameters (properties of drilling fluid), technical equipment (tools, drilling string) are presented in tables. These data were derived from boreholes drilled in the Lublin Coal Basin and the Rybnik Coal District. Drilling difficulties (possible fishing jobs) based on geological conditions characterizing these two regions are discussed. 6 refs.

40891 Present state and future prospects of development of coal pit lighting. Iokhel'son, Z.M.; Machugovskii, N.B. (Sci Res Inst, Makeevka, Donbass, USSR). *Svetotekhnika;* No. 7, 11-13(Jul 1976). (In Russian).

Major advances in the field of coal pit lighting are considered and the future goals to this effect are formulated.

40892 Winning and stowing at 'Bergbau '76' exposition. Sirges, H. *Glueckauf;* **112**: No. 18, 1014-1022(Sep 1976). (In German with English abstract).

Centralization, machinery integration, and enhanced safety measures with growing mechanization trends in coal mining are reported. Improved equipment for coal winning and conveying is shown. 3 refs.

40893 Innovations and trends in face supports at the international mining exposition 1976. Hahn, L.; Irresberger, H. *Glueckauf;* **112**: No. 18, 1023-1028(Sep 1976). (In German).

Equipment and procedures in shielding, and extended applications of existing machinery are demonstrated and evaluated. New devices from various countries are shown.

40894 Road supports at the International Mining Exposition 1976. Goetze, W. *Glueckauf;* **112**: No. 18, 1041-1047(Sep 1976). (In German with English abstract).

New techniques and components already used in practice, and several suggested improvements for coal mines are shown. Conveying devices for construction materials are featured. 2 refs.

40895 Mine surveying and rock bursts prevention at 'bergbau '76'. Bentrup, F.K.; Leiteritz, H.; Wagener, B. *Glueckauf;* **112**: No. 18, 1069-1071(Sep 1976). (In German with English abstract).

Geology and hard coal deposits, land reclamation, and rock stability reports from various countries are discussed. New borehole TV- and digital apparatus for monitoring of tectonic disturbances are introduced. 24 refs.

40896 Mechanical conveying and handling on the 'Bergbau 76'. *Foerdern Heben;* **26**: No. 11, 1152-1158(Sep 1976). (In German). 19 figs.

The international mining exhibition which led all mining experts and supply firms from all over the world to Duesseldorf in May 1976 set many new technological examples. Its main concern was extensive mechanisation and automation of exploitation and drawing techniques. Some of the new developments and progresses particularly concerning hauling systems and components are introduced in this exhibition report.

40897 Roadheading technique at the 9th World Mining Congress. Knickmeyer, W. *Glueckauf;* **112**: No. 18, 1028-1029(23 Sep 1976). (In German).

State of the art is reported including new machinery and procedures developed in various countries' coal mining industry. 9 refs.

40898 Delmas breaks coal output barrier. *S. Afr. Min. Eng. J.;* **88**: No. 4121, 20-21(Oct 1976).

Although the Delmas Colliery has not yet reached its planned production capacity of 250,000 t/month, the mine broke through the 200,000 t/month barrier in June and a production of about 180,000 t can be expected from now on. The colliery, which opened in 1965, was designed as a mechanised mine which would initially produce 150,000 t/month of coal, to be expanded later to 250,000 t/month.

TRANSPORT AND HANDLING

REFER ALSO TO CITATION(S) 40733, 40739, 40780, 40823, 40886, 40887, 40909

40899 (PB—255841) **Study of continuous face haulage systems. Final report.** Cowan, D.M. (Joy Mfg. Co., Pittsburgh, Pa. (USA). Mining Machinery Group). 5 Dec 1975. Contract H0242025. 222p. NTIS $7.75.

This purpose of this contract study was to determine which concepts of continuous face haulage can be developed into a safe, practical, and cost-effective conveyance for application in underground coal mining using the available state-of-the-art. The advantages and limitations of 15 different types of continuous face haulage systems previously or currently used, or being developed, were evaluated as to which ones had the most impact on underground coal mine haulage. The two most promising types of continuous face haulage systems covered by this study proved to be the bridge carrier and flexible conveyor belt systems, although both require more development work to extend their use into a broader range of mining situations and improve their performance and reliability. Included in the report is a list of service requirements for an ideal continuous face haulage system to be used in underground coal mine haulage. (GRA)

40900 (PB—257551) **Investigating storage, handling, and combustion characteristics of solvent refined coal. Task C extension, ball-and-race pulverization and direct firing. Final report.** Downs, W.; Jones, F.L.; Sage, W.L.; Wagoner, C.L. (Babcock and Wilcox Co., Barberton, Ohio (USA). Fossil Dept.). Jul 1976. 126p. NTIS $6.00.

The solvent refining of coal is one of several approaches currently being evaluated by government and private sources to produce a clean fuel from coal. The primary objective of this contract is to characterize certain properties of solvent refined coal including storage, handling, and combustion. Knowing these properties will aid boiler manufacturers to design new units for burning solvent refined coal and to help determine retrofit requirements for existing units. The test program reported here was designed to explore the suitability (or unsuitability) of conventional pulverizing and combustion equipment to pulverize and burn solvent refined coal. This report describes modifications made to the equipment and presents the results obtained therein. Specialized instrumentation was added to the pulverizer during these tests to monitor vibration, torque, speed, etc. These tests are reported in detail. Since several terms used in this report are not in general usage, a glossary of terms and expressions relating to ball-and-race pulverizers and pulverized coal combustion are included. (GRA)

40901 **Technical progress in development of mechanical coal preparation in Poland in the five year period 1971-1975.** Szarafinski, Z. *Przegl. Gorn.;* **32**: No. 7-8, 296-301(1976). (In Polish with English summary).

The production capacities of coal cleaning plants are presented including the basic trends to application of the technical progress in the field of coal preparation technology, of machines and equipment, electrical outfit, automation and architectonic solutions of coal preparation plants. Results are also given.

40902 **Possibility of cleaning Polish coal fines by oil flocculation.** Romanczyk, E.; Lasek, K. *Przegl. Gorn.;* **32**: No. 7-8, 339-344(1976). (In Polish with English summary).

Results of laboratory tests using method are presented for specimens from four Polish coal mines. 3 refs.

40903 **Pneumatic classification of slack coal.** Rees, D.M.; Toynbee, P.A. pp 42-48 of In Coal processing. New York; MSS Information Corporation (1976).

The removal of fines from small grades of sub-bituminous coal improves the performance of these coals in stoker firing. In the preparation of these industrial slack grades in New Zealand, there is no need for washing and the coals are relatively dry. Pneumatic classification has therefore been investigated on a semi-commercial scale with the objective of effecting a separation at a particle size of about 2.5 mm. The work has shown that relatively high efficiencies of size separation can be achieved. The results are applied to the design of commercial equipment.

40904 **Rejection of trace metals from coal during beneficiation by agglomeration.** Capes, C.E.; McIlhinney, A.E.; Russell, D.S.; Sirianni, A.F. pp 97-106 of In Coal processing. New York; MSS Information Corporation (1976).

The rejection of trace quantities of heavy metals from coals during the process of fine grinding followed by selective oil agglomeration of the carbonaceous constituents was examined. Six different steam and coking coals, mainly from Canadian and U.S. sources, were treated. The level of most heavy elements was generally low but, in light of the large throughputs of power plants, the potential environmental hazard may be significant, especially for those elements which are volatile or may form volatile compounds when fired. Many of the trace metals were substantially removed during agglomerative beneficiation of the coal. Some which are apparently in organic association in the coal remained in the agglomerated product. In addition to the reduced environmental hazard, a number of other advantages in upgrading coals prior to use are discussed.

40905 **Coal preparation technique at 'Bergbau '76'.** Leininger, D. *Glueckauf;* **112**: No. 18, 1074-1083(Sep 1976). (In German with English abstract).

New processes reviewed in Congress reports are discussed. Classification, dewatering, and crushing equipment from various countries is shown. 2 refs.

40906 **Coal washing offers benefits.** *S. Afr. Min. Eng. J.;* **88**: No. 4121, 28-29, 33(Oct 1976).

There have been suggestions in coal mining circles that Escom collieries could wash the No. 2 and No. 4 seams to produce a by-product such as a form coke feedstock or steam coal, while using the poor-quality material for power generation. An advantage of this system would be that stones in the run-of-mine coal fed into furnaces, which now cause damage and hold-ups for repairs, would be eliminated in the washing process. It is also claimed that a washing program could be allied to higher extraction underground by increased mechanization, so lengthening the lives of tied collieries and power stations. From such developments one could expect great profitability as well as longer life for the tied collieries.

COMBUSTION

REFER ALSO TO CITATION(S) 40781, 40818, 40821, 41031, 41280, 41659, 41923

40907 (ERDA—76-94/2) **Coal power and combustion. Quarterly report, April—June 1976.** (Energy Research and Development Administration, Washington, D.C. (USA). Office of Fossil Energy). 1976. 53p. Dep. NTIS, PC A04/MF A01.

Construction of the Multicell Fluidized-Bed Boiler facility at Rivesville, West Virginia, is progressing well. The structural, electrical, mechanical, instrumentation, insulation, and material handling systems are nearing completion. Despite extensive reworking of the pipe support system, the base contract piping system is nearly complete. Research continued in the areas of bed cleansing, metal erosion/corrosion, bed agglomeration, and the potential use of spent bed material as a soil nutrient. Studies of the Pressurized Fluidized-Bed Combustor and Turbine Power Generation system included two model combustor tests. A total of 22 different metal alloys was tested for corrosion/erosion effects during these tests. Argonne National Laboratory, during their Supportive Studies of Pressurized Fluidized-Bed Combustion, conducted tests to determine the effect of repeated utilization cycles (sulfation-regeneration) on the performance of sulfur-dioxide accepting additives. Efforts dealing with the Externally Fired Gas Turbine for Modular Integrated Utility System (MIUS) involved the testing of the four-foot square cold flow model and endurance testing of the flow splitter feed system and the prototype furnace coal feed nozzle. Assembly of the modified combustor for Pressurized Fluidized-Bed Combustion Research began. Solvent-refined coal (SRC) product from the Ft. Lewis, Washington pilot plant was tested in the Solvent-Refined Coal (SRC) Combustion Program. Carbon conversion was approximately 99 percent at excess air rates of 20 and 30 percent and only slight deposit formation was noted on the burner surfaces. (LTN)

40908 (MERC/SP—76/3, pp 96-104) **In situ combustion of coal for energy: a progress report.** Chaiken, R.F.; Singer, J.M. (Bureau of Mines, Pittsburgh). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

Work progress on the Bureau of Mines In-Situ Closed Trench Facility at Bruceton is reviewed. With this trench facility, large quantities (approximately 30 tons) of rubblized coal and other carbonaceous material (e.g., roof strata materials plus coal) can be burned in a simulated in-situ geometry. Utilizing a straight burn channel (approximately 1 ft^2 opening and a 2.5 ft web thickness), it is expected that approximately 1 Megawatt thermal power should be generated for several days at optimum burning conditions. Results of further theoretical analyses of the conductive heat losses from an IC combustor are reported. It might be concluded that, in the absence of gas leakage from an IC channel to the ground strata, as much as 80 to 90 percent of the heat of combustion of the coal will appear as sensible heat in the exhaust gas. However, too little information is available on the nature of the roof-fall process and its accompanying effects on channel width and gas leakage to assume that such high thermal efficiencies will be achieved in a practical in-situ combustion scheme. A second point to note is that for fuel-rich burning conditions the heat losses increase fairly rapidly. This suggests that if this type of channel combustor is operated as an underground gasifier, large fractional heat losses will be sustained.

40909 **Method of determining the suitability of a solid fuel for storage.** Babkin, R.L.; Karagodin, G.M.; Protnikova, N.P. (Urals All-Union Sci-Res Inst of Power Eng, USSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 1, 14-17(1976).

A method is described for determining the loss in calorific value of a solid fuel during its low-temperature oxidation by air. The results are given of the testing of a number of coals from different deposits of the Soviet Union performed by this method. The possibility is shown of using this criterion to solve the practical problem of predicting the suitability of a solid power fuel for storage: determination of the time of storage, calculation of the loss of calorific value during storage, determination of the group in relation to oxidation resistance. 6 refs.

40910 **Further development of the burning profile.** Wagoner, C.L.; Winegartner, E.C. (ASME, Pittsburg). pp 25-36 of In Coal I: current advances in coal chemistry and mining techniques. New York; MSS Information Corporation (1976).

It has been shown that the burning profile test can be run in different laboratories using slightly different equipment and comparable results can be obtained. The size and heat capacity of the crucible in which the sample is burned and of the furnace supplying the heat must be considered in addition to the other factors described in detail in the earlier paper by B and W. Although results from

different laboratories may not be identical, they are comparable and can be applied in the same manner, leading to the same conclusions on burning characteristics. The burning profile, although an empirical test, is highly repeatable in a given laboratory and is a useful technique for determining the relative combustion characteristics of a fuel. It provides information on oxidation rates from ignition to completion of burning when used in a comparative manner with profiles from fuels of known field performance. It is especially useful for evaluating unusual fuels where quantities of fuel are not available for full scale burning tests.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 40757, 41601, 41641

40911 (NTISUB/B—127-76/009) **Monthly energy review.** (Federal Energy Administration, Washington, D.C. (USA)). Sep 1976. 96p. (FEA/B—76/377). NTIS $4.00.

See also NTISUB/B/127-76/008.

Contains tables, graphs, and data dealing with production, consumption, and prices of crude oil, natural gas, coal, and petroleum products. (GRA)

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 40816, 40819, 40821, 40880, 40881, 40889, 40891, 40895

40912 (MERC/SP—76/3, pp 434-451) **Experimental coal mine fire research.** Chaiken, R.F.; Singer, J.M. (Bureau of Mines, Pittsburgh). 1976.

From 2. underground coal gasification symposium; Morgantown, West Virginia, United States of America (USA) (10 Aug 1976).

In Proceedings of second annual underground coal gasification symposium.

Model ducts lined with coal are being employed to study the nature of coal mine fires, their rate of propagation, their influence on ventilation air flows and their response to sealing and other fire suppression measures. For scale modeling purposes it is planned to carry out these studies in various size ducts leading to a full size mine entry configuration in the Bruceton multiple entry experimental mine. At present, however, work is being carried out in a 9.1 meter long duct lined with 5 cm thicknesses of coal and insulating brick leaving a 23 by 23-cm-square opening for air ventilation. A number of probes are employed to follow the course of the fire, which is ignited at the upstream end of the coalbed. Thermocouples monitor gas, coal, and brick temperatures; differential pressure probes monitor pressure drop across the fire zone and along the duct; calorimeters measure the amount and distribution of heat flux (radiation and convection) to the coal and brick surface; anemometers measure air velocity profiles. In addition, a number of gas sampling stations positioned along the duct allow for continuous monitoring of the nature of the combustion products (CO, CO_2, H_2, O_2 and CH_4). Experimental data are presented related to various fire characteristics which are believed to be important in actual mine fires. For example, significant throttling of the ventilation air flow has been observed, along with stratified reverse flow of the gaseous combustion products upstream of the fire zone. These phenomena appear to relate in part to the rate of flame spread along the fire bed, the rate of advance of the devolatilization front into the coal, and the gasification rate of flowing coke.

40913 (PB—254823) **Development of fuel cell CO detection instruments for use in a mine atmosphere. Summary contract report, 1 Jan 1975—30 Jan 1976.** Dempsey, R.M.; LaConti, A.B.; Nolan, M.E.; Torkildsen, R.A.; Schnakenberg, G. (General Electric Co., Wilmington, Mass. (USA)). 19 Dec 1975. Contract H0357078. 95p. NTIS $5.00.

Report on Gas Detection Instrumentation Using Electrically Biased Fuel Cell Sensor Technology.

Work has been conducted under Bureau of Mines Contract No. H0357078 to develop a fuel cell sensor instrument for monitoring of carbon monoxide in a mine atmosphere. The approach has been to optimize the fuel sensor cell configuration for the specific detection of carbon monoxide in the presence of other mine gases utilizing recent advances in catalyst, electrode, and solid polymer electrolyte (SPE) technology. Parametric testing has been conducted on two-electrode and three-electrode sensor cells to define performance and life characteristics as a function of temperature, feed flow, and applied sensor voltage. Extended life testing has been conducted on best sensor cells under continuous and intermittent operation with feed gases to define possible life limitations for the mine application. Reliable, efficient gas sampling and electronic control circuitry have been fabricated for use with the fuel cell sensor and integrated into a device to meet the performance and design specifications for a portable, battery-powered handheld direct indicating gas detector for use underground. Four of the production-type instruments have been tested and delivered to the Bureau of Mines under the present contract. The instruments have a meter readout for the range 0 to 50 and 0 to 250 ppM CO in air. A resettable lamp is used for a danger warning signal.

PETROLEUM

REFER ALSO TO CITATION(S) 41600, 41602, 41646, 41647

40914 (NTISUB/B—130-76/004) **Monthly petroleum statistics report, March/April 1976.** (Federal Energy Administration, Washington, D.C. (USA)). Apr 1976. 28p. (FEA/B—76/355). NTIS $4.00.

This report contains monthly petroleum statistics for the months of March and April developed from data collected under the joint Bureau of Mines--Federal Energy Administration Petroleum Reporting System. Data cover crude oil stocks, imports, product stocks, and crude runs-to-stills. (GRA)

40915 **Petroleum derivatives. II. Current research.** New York; MSS Information Corporation (1976). 149p.

Seven papers are included in the volume. A separate abstract was prepared for each paper. (JRD)

RESERVES

40916 **Petroleum and gas resources of foreign countries.** Modelvskii, M.Sh. *Geol. Nefti Gaza;* No. 8, 65-69(1976). (In Russian).

According to an evaluation study carried out in the 1967-1974 period at the Soviet Scientific Research Institute of Foreign Geology, the initial potential geological resources of oil (with condensate) and gas in the capitalist and developing countries on mainlands and in continental shelf areas down to the depth of 500 m amount to about 1140 billion t and 450 trillion m^3 respectively. About 1/3 of the world and gas resources (without the 'socialist' countries) are related to the sea and ocean offshore areas down to the depth of 500 m. Almost a half of the oil and gas resources are concentrated in the Mezozoic deposits; about a third of gas resources are related to Cenozoic complexes. Paleozoic deposits play the least part in the resources of both liquid and gaseous hydrocarbon. About 2/3 of the hydrocarbon resources are located in the 1-3 km depth range. 12 refs.

40917 **Our nation's crude oil and natural gas recoveries may be increased by numerical simulation.** Connaughton, C.R.; Crawford, P.B. pp 747-752 of In Proceedings of the 1976 summer computer simulation conference. La Jolla, CA; Simulation Councils, Inc. (1976).

From Summer computer simulation conference; Washington, District of Columbia, United States of America (USA) (12 Jul 1976).

See CONF-760703—.

Our Nation's energy crisis and its long-range forecast has focused attention on all possible means of increasing the recovery of crude oil and natural gas from our petroleum reservoirs. Using present practices, we may produce one-third of the oil originally in place, yet only a one percent increase would provide an additional 4.5 billion barrels of oil for America. In most oil fields, three fluids, oil, water and natural gas, are all flowing simultaneously. Numerical simulation requires coupling the applicable equations and the solution of several hundred to a few thousand equations in order to simulate the flow of fluids underground. This paper shows the effect of various factors on oil recovery obtained from numerical simulation.

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 40784

40918 **U.s. geological survey's Project BIRDDOG (basic investigation of remotely detectable deposits of oil and gas).** Donovan, T.J. (US Geol Surv, Denver, Colo). pp 414 of In Proceedings of the 14th conference of the Institute of Electrical and Electronics Engineers. New York; IEEE (1975).

From 14th IEEE conference; Houston, TX, USA (10 Dec 1975).

An experimental program to develop an integrated remote sensing-geochemical petroleum exploration technique has been es-

tablished by the U.S. Geological Survey. Briefly, the concept is based on previous and ongoing research which demonstrates that imperfect rock seals capping petroleum and natural gas deposits may permit large volumes of low-molecular-weight hydrocarbons to escape to the surface.

40919 Phase state of hydrocarbons of the Caspian Depression. Serebryakov, O.I. (Lower Volga Sci Res Inst of Geol and Geophys, USSR). *Geol. Nefti Gaza;* No. 8, 50-53(1976). (In Russian).

With an increase in strata temperatures and pressures, changes in physicochemical properties of hydrocarbons take place in the Caspian Depression. This results in changes in the types of deposits. In the eastern part of the depression, gas deposits are rare, oil deposits are found at small depths. In the western part of the depression, gas and gas condensate deposits predominate. An increase in geothermal isoplanes, increase in the athermal flux, and intensification of the hydrogeologically shut-in character of the resources occurs in the westerly direction. These regularities make it possible to predict the chances of finding oil and gas deposit in the Caspian Depression.

40920 Drilling in the St Lawrence Lowlands of Quebec. Thornton, H.P. (Thornton Eng Ltd, Calgary, Alberta). *J. Can. Pet. Technol.;* **15**: No. 3, 42-45(1976).

Cost reduction was of major importance in programming a three-well wildcat drilling project in the St. Lawrence Lowlands region of Quebec. The author explains how an estimated $1.3 million was saved in the drilling of these three wells through an effective engineering approach focusing on a specially designed mud system, deviation drilling, and more effective use of bits and logistics.

40921 Method of structure investigation and deposits research by means of boreholes drilled in circle pattern. Berestka, A.; Sokolowski, J. (Inst Geol, Pol). *Tech. Poszukiwan Geol.;* **15**: No. 3, 31-35(1976). (In Polish with English summary).

Problem of mathematical description and possibilities of recognizing structures before deposit discovery with an assumption that preliminary information is not leading to evaluation of its outline and climax is thoroughly analyzed. Method of drilling in circle pattern which assures gathering of the most detailed data concerning structure's climax and outline with the lowest number of drillings is described. Using of that system is most effective when geophysical methods cannot give proper data about arrangement of oil-bearing zones.

40922 Prospects of discovering oil and gas deposits in the jurassic complexes of west siberia. Zonn, M.S.; Korzh, M.V.; Filina, S.I. (Geol Inst, Acad of Sci of the USSR). *Geol. Nefti Gaza;* No. 8, 6-10(1976). (In Russian).

Regularities of the occurrence of oil and gas complexes in continental (Aalenian and Bathian) and marine (Middle Jurassic) deposits in the territory of the West Siberian platform are considered. Separate calculations of their likely oil-bearing and gas-bearing capacities are made and main directions of exploration of hydrocarbon deposits are pointed out.

40923 Paleogeomorphological preconditions of discovery of petroleum and gas-bearing zones in the Jurassic and Triassic complexes of Northern Emba. Pronicheva, M.V.; Savvinova, G.N. (All-Union Sci Res Min Inst, USSR). *Geol. Nefti Gaza;* No. 8, 21-27(1976). (In Russian).

Relying on the application of the methods of the paleogeomorphological analysis in the Triassic and Jurassic complexes of Northern Emba, the main features of the paleorelief are revealed, the paleostructural plan is determined and a separate approach to the selection of the object of petroleum exploration in these complexes is substantiated. The main exploration zones in the Jurassic deposit are paleovalleys. In the Triassic deposit, it is recommended to carry out exploration above all in the vault parts of domes, determining the sectors of accumulation of alluvial deposits.

40924 Methodology of reservoir rocks separation in the miocene profile of the carpathian foothills using multiple regression analysis. Twardowski, K.; Rychlicki, S. (Akad Gorn-Hutn, Pol). *Tech. Poszukiwan Geol.;* **15**: No. 3, 1-10(1976). (In Polish with English summary).

Methodology for separating reservoir rocks by means of multiple regression analysis used in case of Miocene deposits of the Carpathian Foothills. The Miocene deposits are divided into five depth zones; each zone has its own methodology. The parameter P$sub kol$ is a magnitude characterizing reservoir properties of zones based on gas and water productivity coefficients. 39 refs.

40925 New oil and gas exploration and prospecting directions in the Upper Pechora depression of the pre-Ural trough. Borisov, A.V.; Leshchenko, V.E.; Nosovskii, V.I. (Pechora Sci Res Pet Inst, USSR). *Geol. Nefti Gaza;* No. 8, 1-6(1976). (In Russian).

Characteristics of the tectonic structure of the eastern part of the Upper Pechora depression are considered. A feature of it is a lack of correspondence between the overthrust and the underthrust parts. Compared with the strongly dislocated allochthonous deposits, the autochtonous structure have gentler forms of bedding. This indicates the possibility of existence of a stable structural plan on the territory in question during the processes of Hercynian orogenesis in the Urals.

40926 Method of determination of abnormally high formation pressures from the data of geophysical investigations of boreholes. Dobrynin, V.M.; Serebryakov, V.A. (Moscow Sci Inst of Chem Ind, USSR). *Geol. Nefti Gaza;* No. 8, 32-39(1976). (In Russian).

A method of utilization of the results of geophysical investigations of boreholes for the determination of abnormally high formation pressures (AHFP) of fluid in clayey soils is presented. A new generalized equation is formulated, permitting utilization of different geophysical parameters or physical properties of clayey rocks for the determination of AHFP.

40927 Contemporary structure of the Lower permian sedimentary strata of the Dnieper-Donets depression. Andreeva, R.I.; Chirvinskaya, M.V. (Ukr SSR Sci Res Min Inst, Kiev). *Geol. Nefti Gaza;* No. 8, 60-65(1976). (In Russian).

Based on structural and lithological analysis, using seismic exploration and borehole logging data, characteristic traits of the relationship between the Lower Permian plan and the overlying deposits are presented. The relationship between the Lower Permian and Carboniferous rocks is considered. Recommendations on further explorations in the Lower Permian and Carboniferous deposits are given. 9 refs.

40928 (N—76-27643) **Oil in the mouths of rivers.** Markovskii, N.I. Translated from *Priroda;* No. 2, 100-111(Feb 1976). 22p. (NASA-TT-F—15462). NTIS $3.50.

The value of paleogeographic zoning in oil and gas exploration is discussed. The paleogeographic method is applied to oil and gas-bearing regions of Western Siberia to show the correlation between the location of large deposits and the sites of ancient seashores and estuaries. Productive oil and gas-bearing areas can be correlated with ancient deltas in the U.S.A. as well. Promising areas in the rest of the world are outlined. (Author) (GRA)

40929 Oil and gas from the North Sea. I. Schuermeyer, G. (Dtsch Erdoelversorgungsges, Essen, Ger). *Erdoel Kohle, Erdgas, Petrochem. Brennst.-Chem.;* **29**: No. 9, 391-393(Sep 1976). (In German).

Exploration activities in the North Sea began after the discovery of the Groningen gas field in the Netherlands. Initial major successes were recorded during the mid-1960s. By mid-1976, some 830 exploration wells were drilled. The activities centered mainly on the British and Norwegian sectors. Conservative estimates indicate some 200 million tons/yr of oil may become available for the European market in the early 1980s. The chances of finding oil and gas in the northern part of the North Sea and northern Atlantic are considered to be fairly good.

DRILLING AND PRODUCTION

REFER ALSO TO CITATION(S) 40927

40930 (BERC/IC—77/1) **Carbon dioxide sources and oilfields in a nine-state area of the southwest United States.** Finney, R.E.; Heath, L.J. (Bureau of Mines, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). Apr 1977. 37p. Dep. NTIS $4.00.

Data on the prospective available CO_2 in a nine-state area of the Southwest were collected from scattered sources and compiled to make the information readily available to operators who may be interested in using CO_2 techniques for enhanced oilfield recoveries. Maps of the oilfields in the area studied are provided so that location of supply source can be related to possible point of use. The best potential sources of CO_2 are flue gas from electric generating plants, flue gas from cement plants, output from ammonia plants and natural gas reservoirs. The CO_2 sources are listed by states and include the operator's name, location name, county, and average available amounts of CO_2.

40931 (N—76-28616) **SEASAT economic assessment. Volume 3: offshore oil and natural gas industry case study and generalization. Final report, Feb 1974—Aug 1975.** (ECON, Inc., Princeton, N.J. (USA)). 31 Aug 1975. Contract NASW-2558. 147p. (NASA-CR—148496;REPT—75-125-3B-V-3). NTIS $6.00.

Results are presented of preliminary trade-off studies of operational SEASAT systems. The trade-off studies were used as the basis for the estimation of costs and net benefits of the operational SEASAT system. Also presented are the preliminary results of simulation studies that were designed to lead to a measure of the impact of SEASAT data through the use of numerical weather forecast models. (Author) (GRA)

40932 (PB—254991) **The potential and economics of enhanced oil recovery. Final report.** (Lewin and Associates, Inc., Washington, D.C. (USA)). Apr 1976. Contract FEA-CO-03-50222-000. 274p. NTIS $9.00.

The amount of oil that can be made available through enhanced recovery methods and the time and cost involved in its production are discussed. The report focuses on potential oil reserves in California, Louisiana, and Texas.

40933 Thermal methods of hydrocarbon production--3. Hot fluid drive. principles and laboratory research. Combarnous, M.; Sourieau, P. (Univ de Bordeaux, Fr). *Rev. Inst. Fr. Pet. Ann. Combust. Liquides;* **31**: No. 4, 543-577(1976). (In French with English abstract).

Several recovery or stimulation techniques by hot fluid injection (water or steam) are described. The mechanisms involved in these techniques are discussed together with the limits in the application of the processes. A study of the relative stability of hot fluid displacements, and information on oil recovery and sweep efficiencies are presented. 61 refs.

40934 Possibilities of biopolymer utilization for drilling fluids. Okrajni, S.; Glados, S.; Stomma, J. (Osrodek Badaw-Rozwojowy Tech Geol, Pol). *Tech. Poszukiwan Geol.;* **15**: No. 3, 13-15(1976). (In Polish with English summary).

Rheological properties of drilling fluids based on biopolymers are presented. Using of biopolymer drilling fluids gives some economic profits because of small consumption of main drilling fluid's raw materials. Results of theological investigation of fluids prepared with the additive XPS KELCAN biopolymer are presented and discussed. 22 refs.

40935 Design, material and production - a complex problem within shipbuilding. Janzen, S. *Svetsen;* **35**: No. 3, 67-80(1976). (In Swedish).

The article describes improvements in the steels used in the construction of offshore platforms with regard to the resistance to brittle fracture. New calculation methods have been adopted taking into account the increase in the size of ships. The changes applied to production techniques in shipbuilding in Sweden - in particular, automation - are discussed. 27 refs.

40936 Materials and welding related to the construction of fixed offshore installations. Valland, G.; Olbjorn, E. *Svetsen;* **35**: No. 3, 103-116(1976). (In Swedish).

The resistance to brittle fracture, fatigue and corrosion of fixed offshore installations are considered. A description of typical installations used in the North Sea is given. The influence of environment and load on design, size and choice of materials and requirements relating to steel and filler materials, construction and repairs, and non-destructive testing are discussed. 14 refs.

40937 Recent surface movements in the Baldwin Hills, Los Angeles County, California. Castle, R.O.; Yerkes, R.F. *U.S., Geol. Surv., Prof. Pap.;* No. 882, 1-132(1976).

The various clearly defined spatial and temporal relations between subsidence and oil-field operations that have been demonstrated both for this and other oil fields indicate that the differential subsidence and associated horizontal movements generated in the Baldwin Hills are due to exploitation of the Inglewood oil field. This conclusion is strengthened by various theoretical considerations and a host of experimental studies. Neither the actual changes in groundwater and loading conditions nor the effects of the maximum conceivable changes in these regimens can explain the observed subsidence; tectonic activity is considered an equally implausible explanation of the differential subsidence. Another conclusion is that the contemporary cracking and faulting are also due largely or entirely to the exploitation of the Inglewood oil field. Maps are included in the back pocket. Refs.

40938 Chemistry of petroleum processing and extraction. III. New York; MSS Information Corporation (1976). 225p.

Eleven papers are included in the volume. A separate abstract was prepared for each paper. (JRD)

40939 Analysis of the acidizing process in acid fracturing. van Domselaar, H.R.; Schols, R.S.; Visser, W. pp 65-96 of In Chemistry of petroleum processing and extraction. III. New York; MSS Information Corporation (1976).

The theoretical analysis of the acid-fracturing process for turbulent-flow conditions has been reconsidered taking fluid losses into account. For a simple fracture model and an idealized acidizing process, the acid concentration in the fracture during acid injection and the fracture width have been determined as functions of time and place for three loss conditions: (1) no fluid loss, (2) fluid loss proportional to time, and (3) fluid loss proportional to the square root of time. From the results of the analysis, it is concluded that even under the unfavorable conditions of turbulent flow in the fracture and fluid loss, acid penetration is, in general, not a limiting factor in the application of the acid-fracturing process. However, it will not be possible to predict the productivity increase resulting from a given treatment until more experimental data on the conductivity of etched fractures and on certain aspects of the reaction kinetics have been gathered.

40940 Successful stimulation of deep wells using high proppant concentrations. Holditch, S.A.; Ely, J. pp 108-122 of In Chemistry of petroleum processing and extraction. III. New York; MSS Information Corporation (1976).

Aspects of hydraulic fracturing for oil well stimulation are reviewed. Information is included on injection fluids, the Vicksburg formation, and economics. Data are presented to show that an effective means of stimulating deep, low-permeability gas wells has been developed. The success of the high-viscosity, high-proppant-concentration method is attributed to its ability to create and pack a wide fracture. In low-permeability formations, it is possible to increase recovery by decreasing the abandonment pressure. (JRD)

40941 Asphaltene flocculation during solvent stimulation of heavy oils. David, A. pp 123-140 of In Chemistry of petroleum processing and extraction. III. New York; MSS Information Corporation (1976).

The declining recoverable oil reserves have attracted attention to the vast reserves of heavy crude oils. It has been suggested to use solvent stimulation as one technique for recovery of additional oil. The main benefits of this method are that by choosing an appropriate solvent, the viscosity of the oil is greatly reduced, and the reservoir pressure is increased. Problems may develop, however, if the asphaltene content of the oil is high. When the asphaltenes contact the solvent they may flocculate and plug the producing formation. Experimental results show that the following parameters increase the flocculation and formation plugging: lower molecular weight and higher concentration of solvent, higher asphaltene content in the oil and lower rock permeability. The effect of temperature on plugging is dependent on the type of oil.

PROCESSING

REFER ALSO TO CITATION(S) 40973, 40990

40942 Computer simulation of tower operation with two and three crude oil feed inlets, for partial topping of crude. Kondrat'ev, A.A.; Frolova, L.N.; Khasanov, Z.K.; Deineko, L.S.; Bakaushin, V.Ya.; Shin, P.Ch. (Ufa Pet Inst, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 1-2, 14-17(1976).

For the purpose of creating vapor in the stripping section of the first tower of an atmospheric-vacuum pipe-still unit, it has been proposed to use part of the crude oil, heated to high temperature. Refinery experience and computerized calculations indicate that such a method of introducing heat into the tower is simpler and better than the introduction of heat by a hot jet, if the naphthas of both towers are subjected to joint stabilization in order to remove gases and hydrogen sulfide. In a table the authors present calculated data on the separation of a light naphtha and topped crude, for four variants of heat supply to the tower. The calculations were performed on an M-222 computer, with allowance for thermal interaction of the streams and the introduction of steam into the lower part of the tower in amount of 0.25% by mass on crude oil. An algorithm of a modified relaxation method (flash vaporization) was realized in the program of the calculation. Computer simulation of the operation of a tower, with accounting for the thermal properties and the feed of steam, has made it possible to determine quantitatively the variation in fluxes up and down the crude oil tower, and to clarify the specific features in fractionation of mixtures boiling over wide temperature ranges. 5 refs.

40943 Operation of primary fractionation tower in unit for pyrolysis of liquid hydrocarbons. Aerov, M.E.; Rybina, L.P.; Gandman, Z.I.; Balykina, G.V.; Chernukhina, V.G.; Firsov, V.I. *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 1-2, 39-42(1976).

In the production of lower olefins, recent years have seen a trend toward the use of middle-distillate cuts as pyrolysis feedstocks, along with the use of more severe conditions. This type of operation gives higher contents of high-boiling hydrocarbons in the pyrolysis products, and also greater amounts of coke and compounds that are susceptible to polymerization. In many modern ethylene units, provision has been made for a primary fractionation section to separate the pyrolysis products and to use the heat of the pyrolysis gas (300-200$degree$C) in preheating the pyrolysis feedstock and the water fed as steam diluent, and also to generate low-pressure steam. This paper reviews operating conditions of a petrochemical plant in which pyrolysis gas is prepared for separation by using primary fractionation tower. It is demonstrated that, in normal operation of a primary fractionating tower under conditions of medium-temperature pyrolysis of straight-run naphtha, there is no need to feed the still bottom with additional material from outside. When the improved condensation scheme is put into effect, using 'cold' reflux and minimum temperatures of the tower bottoms, it becomes possible to

minimize the extent of thermal effects on the products being separated, and to stabilize the tower operation. 2 refs.

40944 Experience in operating catalytic reforming reactor with radial feed input and thin bed of catalyst. Sycheva, A.M.; Abrosimov, B.Z.; Mel'nikov, S.M.; Fadeev, I.G.; Yaroslavtsev, A.D.; Chekunova, E.I.; Gendel'man, B.G.; Morozov, V.F.; Mironov, V.M.; Shipitsyn, V.I. *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 1-2, 43-45(1976).

This paper presents results of an experimental program in which catalytic process reactors with a stationary catalyst bed and radial feed input were designed, built and tested in industrial conditions. Design of operational details are given along with properties of products of catalytic reforming. A regenerated AP-56-platinized alumina catalyst was used in this reactor. The catalyst charge in the modernized reactor was 1900 kg, that in the unmodernized reactor 2168 kg. Over the course of six months of operation, 67,000 metric tons of feedstock passed through the reactors. The operating indices of these reactors during the first run are tabulated. The results of this commercial test confirmed the significant advantages in the design of reactors with radial feed inlet, in comparison with reactors with axial feed inlet.

40945 Analysis of operation of topping tower in high-capacity unit for crude oil distillation. Pikalov, G.P.; Molokanov, Yu.K.; Korotkov, P.I.; Rudkovskii, A.D. *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 1-2, 88-93(1976).

In correlating the operating experience with high-capacity refinery equipment that has been put into service in previous years, and in determining the reserves in such equipment for further increases in capacity, it is of great importance to follow the operation of fractionating towers in high-capacity units. For this purpose, on a high-capacity ELOU-AVT unit (electric desalting unit/atmospheric-vacuum pipestill unit) at the Polotsk refinery, operations were followed for several working regimes of the K-1 topping tower, these regimes typically include high levels of overhead product takeoff and high reflux ratios. This article is devoted to an analysis of the results that were obtained in these operating tests. The basic operating conditions of the K-1 tower are listed for the different regimes; product quality indices are also listed. The practical operating data obtained on the K-1 tower operation were used in calculating the heat fluxes for the input from the 'hot jet' and the removal in the condenser, as well as the reflux ratios, the number of theoretical trays, and the hydrodynamic operating parameters of the tower. Design recommendations are presented and realized in the improved distillation units. As a result, six four-pass valve trays and four perforated cascade trays were installed in the stripping section; this made it possible to lower the specific liquid load from approximately 200 to 125 $m^3/(m.h)$ and to achieve 40% above design capacity for the unit. Normalization of the operating regimes of the stripping section in the K-1 topping tower made it possible, with reflux ratios below the design level (0.5-0.6), to achieve up to 98% recovery of the propane-butane cut from the crude oil into the naphtha from the K-1 tower. Along with this, a stable naphtha is obtained from the K-2 atmospheric tower. 5 refs.

40946 Gas distributor grids for high-temperature processes in fluidized bed. Stadnik, V.F.; Brun-Tsekhovoi, A.R.; Evreinov, A.N.; Il'enko, B.K. (Inst of Pet Synth, Acad of Sci of the USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 1-2, 125-128(1976).

This paper presents some considerations which should be taken into account when designing grids for high-temperature processes, in particular for the combustion of gas in a fluidized bed in order to prevent ignition of the combustible mixture before it enters the fluidized bed. Ignition usually occurs as a result of breakthrough of the flame through the openings of the grid and through heating of the grid parts to the ignition temperature of the mixture. Gas distributor grids under consideration are aimed at the application under conditions of the steam conversion process in a fluid catalyst bed. In this process, the circulating heat carrier is heated by combustion of gas in a fluidized bed to a temperature of 1100-1300°C at a pressure of 20-30 kgf/cm^2. Several variants of the grid design are shown in a figure. Design characteristics, testing conditions and operating parameters of a grid are tabulated. The grids described in the paper can be used not only in gas combustion, but also in carrying out reactions in a fluidized bed with substances that form combustible and explosive mixtures; examples of such reactions are oxidation and oxidative chlorination. 6 refs.

40947 Possible use of expansion turbines in gas and petroleum industries. Verneau, A. (Soc Bertin and Co, Fr). *Rev. Inst. Fr. Pet. Ann. Combust. Liquides;* **31**: No. 3, 471-501(1976). (In French with English abstract).

Turbine utilization for recovering fluidic energy is discussed. This energy can be used to drive compressors, pumps or power generators. Such turbines exist mainly in the 200 hp to 20,000 hp range. Axial flow turbines and radial flow turbines and the technical singularities and the areas of application of each type are presented. Special emphasis is placed on low power ratings (from one hundred to a few hundred kilowatts). The pattern of evolution of efficiency versus power is considered, and certain special types particularly well-suited to this range, such as peripheral turbines, are described. A few indications concerning energy recovery from liquids by means of turbines are also given. Examples of application, such as recovering the condensable fractions of natural gas (butane, propane, ethane), recovering waste gas, recovering fluidic energy during distribution and underground storage, gas scrubbing hydraulic turbines,. recovering the energy from catalytic cracking fumes, and driving small-power generators rating from a few kilowatts to several hundred watts are shown. The technology and special design aspects, with special emphasis on problems connected with regulation, gastightness and turbine bearings, are discussed. Advanced techniques, such as the use of gas bearings and their advantages, are described. The difficulties stemming from low temperatures and condensation are examined. In conclusion considerations from an economic point of view are proposed on the profitability of an energy recovery plant.

40948 Improvement of raw materials for catalytic cracking. Bukowski, A.; Gurdzinska, E. (Politech Warszawska, Plock, Pol). *Przem. Chem.;* **55**: No. 10-11, 533-535(1976). (In Polish).

Studies were carried out on the influence of cumene hydroxyperoxide at higher temperatures on properties of atmospheric residue of Romaszkin crude and on composition and quantity of fraction 350--490°C obtained during its vacuum distillation. There has been established a rise in coke content in the atmospheric residue annealed in presence of cumene hydroxyperoxide. Distillation under reduced pressure of the residue prepared in the way described above leads to a marked rise in the quantity of fraction within b.p.'s range 350--490°C. This fraction is characterized by a lower ability to coking and a lowered content of heavy metals. The method that has been developed makes possible an increase in quantity and an improvement in quality of the raw material for catalytic cracking. 18 refs.

40949 Chemistry of petroleum processing and extraction. II. New York; MSS Information Corporation (1976). 313p.

Nineteen papers are included in the volume. A separate abstract was prepared for each paper. (JRD)

40950 Deasphalt to get feed for lubes. Ditman, J.G. pp 10-18 of In Petroleum derivatives. II. Current research. New York; MSS Information Corporation (1976).

Yield and quality of products from pilot plant deasphalting of vacuum residues over a wide range of yields show the value of the solvent deasphalting process to recover lubricating oil, or other feedstocks for catalytic processing, from residues. The suitability of the products from seven different vacuum residues for various uses particularly as feedstocks for lubricating oil manufacture are discussed.

40951 Hydrodenitrogenation of petroleum-model-nitrogen compounds. Aboul-Gheit, A.K.; Abdou, I.K. pp 77-93 of In Petroleum derivatives. II. Current research. New York; MSS Information Corporation (1976).

Representative petroleum nitrogen compounds, dissolved in paraffin oil, are hydrogenated in a stirring batch autoclave using a cobalt-molybdenum-alumina catalyst. After eliminating mass transfer and diffusion limitations through optimizing the autoclave stirring speed and catalyst particle size, the kinetic parameters of the hydrodenitrogenation reaction are investigated under conditions of 200 atm hydrogen pressure, reaction temperatures between 350 to 400°C, and reaction periods up to six hours. The hydrodenitrogenation reaction of both basic and non-basic compounds is found to be pseudo-first-order as determined via both integral and differential approaches. The ring splitting step involved in hydrodenitrogenating the 6-membered compounds is most probably responsible for their high values of energies and enthalpies of activation. The higher negative entropies of activation obtained in hydrodenitrogenating the 5-membered ring compounds may be due to their relatively immobile rearrangement when adsorbed on the catalyst. The nature (basicity) of a nitrogen compound influences its hydrodenitrogenation mechanism irrespective of its geometrical configuration .

40952 Evaluating refinery process side corrosion inhibitors. Gutzeit, J.; Samans, C.; Bulls, F.B. pp 94-105 of In Petroleum derivatives. II. Current research. New York; MSS Information Corporation (1976).

Although laboratory tests cannot duplicate all variables which affect the performance of corrosion inhibitors in modern petroleum refining units, they are useful screening procedures which can go a long way in identifying inhibitors to be considered for field evaluation. Details of the tests used by Amoco Oil are presented which include a continuous flow test at 300°F and 650 psig. This test is useful in screening inhibitors for high pressure desulfurizer, reformer, and hydrocracker effluent streams. According to the data cited in the examples, substituted cyclic amines are effective corrosion inhibitors for many petroleum refinery process applications.

40953 Hydrocracking of polynuclear aromatic hydrocarbons over silica-alumina based dual functional catalysts. Qader, S.A. pp 10-34 of In Chemistry of petroleum processing and extraction. II. New York; MSS Information Corporation (1976).

Mechanisms of hydrocracking of naphthalene, anthracene, and pyrene were found to proceed through sequential occurrence of hydrogenation, isomerization, and cracking reactions. Hydrocracking reactions were found to follow first order kinetics and hydrocracking data were found compatible with the dual site mechanism of Langmuir-Hinshelwood. Cobalt sulfide + silica-(low) alumina combination was found to be the most active catalyst in the hydrocracking of polynuclear aromatic hydrocarbons. The yield of coke in hydrocracking varied in the order naphthalene less than anthracene less than pyrene.

40954 Effects of diffusion resistance on gasoline selectivity in catalytic cracking. Pachovsky, R.A.; Wojciechowski, B.W. pp 35-48 of In Chemistry of petroleum processing and extraction. II. New York; MSS Information Corporation (1976).

The time on stream theory of catalyst decay is applied to gas oil cracking selectivity data from a static bed reactor operating with a diffusion limited catalyst. It is found that intraparticle diffusion affects the reactions leading to the disappearance of gas oil to a much greater extent than the reaction leading to the recracking of gasoline and catalyst poisoning. Reasons for this behavior are postulated. It is also found that the overall kinetic order for the rate of disappearance of gas oil is decreased with the result that maximum selectivity occurs at a higher conversion value than for a corresponding diffusion-free catalyst. It is concluded that diffusion limitation is not a serious problem with respect to gasoline selectivity in commercial reactors.

40955 Diffusion effects in catalytic gas oil cracking. Best, D.A.; Pachovsky, R.A.; Wojciechowski, B.W. pp 49-57 of In Chemistry of petroleum processing and extraction. II. New York; MSS Information Corporation (1976).

It is shown that the introduction of diffusion limitations has no effect on the mechanism of catalyst aging. This conclusion is based on the fact that the same value of N is obtained for both the diffusion free and diffusion limited forms of the same catalyst. Diffusion limitations are shown to reduce the reaction velocity by reducing the effective rate constant, K. At the same time, a diffusion limited catalyst ages less rapidly than a diffusion free catalyst. This result arises from the observation that the value of G is smaller in the diffusion limited case while N is not changed by diffusion limitations. Diffusion limitations make the feed stock appear to the catalyst to be more homogeneous, as shown by a smaller value of W in the diffusion limited case. No preferential cracking of the feed by the diffusion limited catalyst is indicated in our case. It is suggested that as a result, the cycle stock from a diffusion limited catalyst should be less refractory than the cycle stock from a diffusion free catalyst.

40956 Theoretical interpretation of gas oil selectivity data on x-sieve catalyst. Pachovsky, R.A.; John, T.M.; Wojciechowski, B.W. pp 58-69 of In Chemistry of petroleum processing and extraction. II. New York; MSS Information Corporation (1976).

A six-parameter multiresponse model based on the catalyst aging theory of Wojciechowski (1968) is applied to experimental selectivity data in gas oil cracking. Within the range of conditions studied, the model gave an adequate fit to the data. It was found that the selectivity curves at various cat/oil ratios were contained within optimum and minimum performance envelopes but that the relationships between these envelopes and the selectivity curves were not quite as simple as had previously been reported for a theoretical example (Campbell and Wojciechowski, 1969). The optimum time-on-stream for each of the cat/oil ratios was about one minute. Maximum gasoline production was 59 weight percent at 81 weight percent total cumulative conversion, resulting in a gasoline efficiency of 72.8 percent.

40957 Kinetic model for the prediction of hydrocracker yields. Stangeland, B.E. pp 70-84 of In Chemistry of petroleum processing and extraction. II. New York; MSS Information Corporation (1976).

A description of the yield changes that occur during hydrocracking is complicated by the large number of different molecules involved. Here a kinetic model is discussed that represents this wide spectrum of compounds as a series of 50°F boiling range cuts. Each of the heavier cuts cracks via a first-order reaction to form a series of lighter cuts. One parameter describes the effect of boiling point on the rate constant. Two other parameters determine what products will be generated as each cut cracks. With a feed distillation and values for these three parameters, the model predicts product distillation curves as a function of conversion level for both once-through and recycle liquid operation with a standard error of about 1 percent. Values for these parameters are given for a variety of feeds and catalysts. They depend on catalyst type and feed paraffin content.

40958 Pilot plant proves Resid process. Mosby, J.F.; Hoekstra, G.B.; Kleinhenz, T.A.; Sroka, J.M. pp 217-230 of In Chemistry of petroleum processing and extraction. II. New York; MSS Information Corporation (1976).

Numerous resids of widely varying properties have been desulfurized in a proprietary process developed by Amoco. Called Resid Ultrafining, the process gave excellent results in both bench-scale and large pilot plant equipment. The results of a six-month demonstration run and orienting cost information are presented. Commercially acceptable cycle lengths can be attained with no problems of catalyst bed plugging. Costs depend on the feed properties and the desired product sulfur level, but are generally in the range of $0.70 to $1.05 per barrel.

40959 Non-ideal liquid activity coefficients. Russell, R.A. (Badger Co, Inc). *Erdoel Kohle, Erdgas, Petrochem. Brennst.-Chem.;* **29**: No. 9, 407-409(Sep 1976).

There are a number of methods available for correlating liquid phase activity coefficients in binary vapor-liquid equilibrium systems and for predicting activity coefficients in multicomponent systems using the interaction parameters from the binary correlations. Two commonly used equations, Wilson and NRTL (Non-Random, Two-Liquid) consider the interactions between all component pairs in the calculation of each activity coefficient. The author shows how to simplify the calculation effort when using these two equations for predicting activity coefficients. The simplified calculation may be used to simulate a distillation tower or an entire chemical process. 2 refs.

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 40943, 40944

40960 Investigation of the dependence of the properties of carbonaceous materials on the structure of a petroleum coke filler. Averina, M.V.; Virgil'ev, Yu.S.; Nikolaev, A.I.; Makarchenko, V.G.; Pekal'n, T.K.; Ostronov, B.C.; Sinel'nikov, L.Z. *Solid Fuel Chem. (USSR) (Engl. Transl.);* **9**: No. 6, 120-125(1975).

In the reported investigation, the properties of the carbonaceous materials investigated, obtained by the same technology, are determined by the structural features of the coke fillers. An increase in the size and anisometry of the structural elements of the cokes leads to a corresponding increase in the dimensions of the crystallites (region of coherent scattering) and to an increase in the degree of perfection of the crystal lattice of the graphitized materials prepared from them. The physicomechanical characteristics of the materials investigated depend on the structural features of the cokes used and are determined mainly by the diameter of the crystallites. 12 refs.

40961 Classification of petroleum-derived fuels. Gulin, E.I.; Gorenkov, A.F. *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 1-2, 31-32(1976).

This paper discusses principles and techniques of classification of liquid fuels obtained from petroleum in Russian refineries. The relevant Soviet standards are reviewed. Classification of fuels is tabulated in the following sequence: group, kind, grade, and type.

40962 Influence of dissolved water on static electrification of jet fuels. Primenko, V.I.; Poboiskii, O.E. *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 1-2, 33-34(1976).

This paper is concerned with the generation of static electric charges in jet fuels in presence of water which may be dissolved, emulsified or in the free state. Jet fuels will differ in dissolved water content, depending on the chemical composition of the fuel. The most hygroscopic fuels are those with high contents of aromatic hydrocarbons. All types of jet fuels manifest a reversible hygroscopicity; it is considered that the water dissolved in the fuel exists in the form of individual molecules and that it does not enter into any chemical bonding. Because of its molecular volume and considerable dipole moment, water has a high tendency toward static electrification; but, owing to its high conductivity, relaxation of the charges that are formed will take place almost instantaneously. It is shown experimentally that the dried samples of the test fuels, when pumped through the pipe at a flow velocity of 3.2 m/sec and a temperature of 25°C, acquired a negative charge. As the fuel picked up hygroscopic water, the charge reversed sign and became positive. When the fuel has accumulated hygroscopic water, there is apparently a change in signs of the electrical double layer, as a result of which one sees a decrease of the negative charge to zero and then an increase of the positive charge. 4 refs.

40963 Service properties of jet fuels in relation to group composition of sulfur compounds in fuel. Chertkov, Ya.B.; Seregin, E.P.; Kirsanova, T.I.; Romanov, A.N.; Lifanova, T.A.; Skovorodin, G.B. *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 1-2, 63-66(1976).

Most middle-distillate fuels are produced from medium- and high-sulfur crude oils. Even with the increasing use of hydrotreating processes, jet fuels still contain sulfur compounds that may vary in

group composition. It has been established that straight-run fuels, as produced today, contain only four groups of sulfur compounds: oxidized sulfur compounds (3-15%), mercaptans (about 2%), and sulfides and thiophenes (<90%). Depending on the type of crude, the fuel may contain sulfides, thiophenes, or mixtures of these materials. This paper reports results of an investigation which was undertaken in order to study the influence of the individual groups of sulfur compounds present in commercial jet fuels on the service properties of these fuels, while taking measures to eliminate the influences of other organometallic compounds. The following properties were evaluated: thermal stability, metal corrosion, lubricity, and electrical charging tendency. Experimental data are tabulated, plotted and discussed in terms of practical recommendation. 4 refs.

40964 Curtailment of time required to determine gasoline induction period. Kyuregyan, S.K.; Demidenko, K.A.; Levinson, G.I. *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 1-2, 67-68(1976).

The chemical stability of automotive gasoline produced to meet GOST 2084-67 is characterized by the content of existent gum and the length of the induction period for oxidation. The existent gum content indicates the degree of oxidation of the gasoline at the moment of determination; it does not give any prediction of the behavior of the gasoline in the future. The length of the induction period is used to judge the susceptibility of the gasoline to oxidation during storage. Essentially, this method consists of a determination of the time during which the gasoline remains essentially unoxidized, with an oxygen pressure in the bomb of 7 kgf/cm$sup 2$ and a temperature of 100°C. The methods of determination of the induction period are identical in GOST 4039-48, ASTMD 525, and IP 40. However, the time required to determine the induction period may be as great as 60 h in some cases. The present work was aimed at a curtailment of the time required to determine induction period, without any change in the essence of the method or in the apparatus design. Details of the procedure developed are given and results of a test program are tabulated. 2 refs.

40965 Experimental investigation of heat capacity of Samotlor crude oil and cuts from this crude. Rastorguev, Yu.L.; Grigor'ev, B.A.; Ganiev, Yu.A.; Andolenko, R.A. (Pet Inst, Groznyi, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 1-2, 75-77(1976).

This paper presents results from an experimental determination of the isobaric heat capacity C/sup p/ of Samotlor crude oil and 18 cuts from this crude, the measurements being made over a range of temperatures from 20 to 200°C. The measurements of heat capacity of the crude oil and the cuts were performed in two experimental units using a direct heating procedure in an adiabatic calorimeter. Measured data are tabulated and evaluated by using empirical formulas describing interdependence of temperature coefficient and heat capacity. 8 refs.

40966 Molecular structure of pyrolysis coke. Polyakova, A.A.; Kogan, L.O.; Rabinovich, I.S.; Samchuk, G.I.; Muchinskii, Ya.D. (0104). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 1-2, 110-111(1976).

The technology of producing pyrolysis coke includes calcination of the coke mass in the last stage of coking in the still. Coke obtained from highly aromatic pyrolysis tars typically has a rather low evolution of volatile compounds (on the average below 3.5% by weight), the volatile matter consisting of 95-98% hydrogen and methane by volume; in this respect the pyrolysis coke is the same as coke produced from coal. In elucidating the mechanism through which the volatiles are formed, the authors investigated two samples of coke produced from the same tar but under different coking conditions. The coking conditions and certain characteristics of these coke specimens are tabulated. The coke specimen analyses were performed mainly through mass spectrometry. The aromatic hydrocarbons in specimen were found to have a greater number of phenyl rings per molecule. The most typical of these hydrocarbons are the compounds $C_{27}H_{14}$ and $C_{27}H_{16}$, each containing one methyl group. The results obtained in this work indicate that the quantity of volatile compounds may be an index to differences in molecular structure of pyrolysis cokes.

40967 Group composition of sulfur compounds in distillate fuels and method for determining this composition. Chertkov, Ya.B.; Seregin, E.P.; Kirsanova, T.I.; Romanov, A.N.; Lifanova, T.A. (0301). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 1-2, 154-157(1976).

A method is described which has been developed for the systematic determination of the group composition of sulfur compounds present in distillate fuels: mercaptans, sulfides, thiophenes, and oxygen-containing compounds. A technological method is proposed for quantitative recovery from the fuels (without change in original composition) of oxygen-containing compounds, high-purity sulfides, and thiophenes in the form of a thiophene-aromatic concentrate. These methods have been used in establishing the group composition of the sulfur compounds present in distillate fuels. It has been shown that with increasing mol. wt (boiling point) of the sulfur compounds, the relative amounts of thiophenes and oxygen-containing products increase, and the relative amount of sulfides decreases. In diesel fuels and in heavy distillate fuels, disulfides are sometimes detected in quantities equivalent to the normal content of mercaptans; oxidation of mercaptans may explain the presence of disulfides. 4 refs.

40968 Mass-spectrometric analysis of group composition of saturated petroleum hydrocarbons in crude oil. Brodskii, E.S.; Lukashenko, I.M.; Volkov, Yu.A. (0104). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 1-2, 158-161(1976).

Mass spectrometry is widely used in the analysis of group composition of petroleum hydrocarbons; through this approach, the contents of n-paraffins, isoparaffins, and mono-, bi-, tri-, and tetracyclic naphthenes can be determined. However, the information obtainable through mass spectrometric analysis can be broadened considerably by increasing the number of hydrocarbon groups determined. Study of the mass spectra of paraffinic and naphthenic hydrocarbons with various structures is presented. It indicates that differences in the mass spectra of isomers can be used as a basis for separate determination of these isomers. Determination of the concentrations of hydrocarbon groups is accomplished by solving a system of linear equations that takes into account the mutual overlapping of the mass spectra of the different groups of hydrocarbons. The mass spectra of isomers, despite their differences, are actually quite similar; hence the matrix of the system is obtained with insufficient conditionality, and this may lead to errors in solving the system. Results from analysis of petroleum fractions are tabulated and evaluated by means of equations derived. 7 refs.

40969 Influence of polymeric additives on petroleum wax properties. Bogdanov, N.F.; Parfenova, L.A. (Pet Sci-Res Inst, Groznyi, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 1-2, 10-13(1976).

Polymeric additives are used to raise the melting point, increase the mechanical strength, and lower the water vapor transmission of petroleum wax formulations. Of the polymeric additives that were tested, the best material is the PE wax. With the PE wax, the concentration curves for the variation in melting point and penetration of the wax formulations are steeper, and the viscosity curves flatter, than those for the formulations containing the other polymeric additives. These polymeric additives give significant reductions in water vapor transmission of the blends at relatively low polymer contents (1-2%). 2 refs.

40970 Petroleum derivatives. I. Current research. New York; MSS Information Corporation (1976). 168p.

Thirteen papers are included in the volume. A separate abstract was prepared for each of eleven papers. (JRD)

40971 Liquid—liquid extraction in the petroleum and petrochemical industry. Bailes, P.J. pp 72-76 of In Petroleum derivatives. II. Current research. New York; MSS Information Corporation (1976).

Liquid-liquid extraction as a means of separating petrochemical materials according to chemical structure rather than boiling point is examined. Process arrangements and solvent systems are described. (JRD)

40972 Lubricant chemistry. Lansdown, A.R. pp 132-145 of In Petroleum derivatives. I. Current research. New York; MSS Information Corporation (1976).

The preparation and properties of lubricants are reviewed. Information is included on mineral oils, synthetic liquids, lubricant rheology, additives, greases, solid lubricants, metal working lubricants, tribochemistry, and lubricant analysis. (JRD)

40973 Energy savings in propylene/propane splitting. Schulze-Trautmann, H. (Dtsch BP, Hamburg, Ger). *Erdoel Kohle, Erdgas, Petrochem. Brennst.-Chem.;* **29**: No. 9, 403-407(Sep 1976). (In German).

Three different process designs for fractionation of propylene and propane are investigated: (1) Conventional distillation with LP steam boiler; (2) Two columns in parallel operation; and (3) Distillation using the heat-pump principle. The economic comparison shows that the heat-pump principle offers a significant advantage over the two other designs, not only in energy savings but also in slightly lower investment costs. 5 refs.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 40911, 41601, 41638, 41645

40974 (PB—254693) Structure and competition within the petrochemical industry and economic impact of 1973—1974 petrochemical shortage. Final report. (Chem Systems, Inc., New York (USA)). Mar 1976. Contract FEA-CO-03-50232-00. 384p. NTIS $10.75.

This report is designed to answer a number of questions pertaining to the petrochemical industry which were an outgrowth of the Federal Energy Administration's 'Report to Congress on Petrochemicals' in 1974 and the October 9, 1974 hearings on petrochemicals conducted by the Permanent Subcommittee on Investigations, Committee on Government Operations of the United States Senate. The report outlines the structure of the U.S. petrochemical industry, and the economic impact on various industries of the 1973-1974 shortages in petrochemical materials. It was beyond the scope of this report to analyze in detail the complex nature of the petrochemical industry. Information has been provided on general industry practices during recent years and also during the 1973-1974 period of petrochemical shortages. Analysis of specific company practices during these periods was beyond the scope of this report. (GRA)

40975 (PB—254943) **Selling prices and taxes on motor gasoline, diesel fuel, and heating oil in selected countries, as of October 1974. International economics report 1974.** (Office of Economic Research, Washington, D.C. (USA)). Feb 1975. 6p. (OER/ER—6). NTIS $3.50.

The report provides data on the selling prices and taxes on some refined petroleum products in the United States and in other developed and less-developed countries. The refined petroleum products covered are: premium and regular motor gasoline, diesel fuel, and heating oil. (GRA)

40976 (PB—254944) **The impact of the proposed energy conservation program on U.S. foreign trade in manufactures, with an emphasis on petrochemicals. International economics report 1965—1976.** (Office of Economic Research, Washington, D.C. (USA)). Feb 1975. 97p. (OER/ER—7). NTIS $5.00.

This report analyzes the possible effects of the President's January 1975 energy conservation program on U.S. foreign trade in manufactured goods, in particular the effects on the U.S. petrochemical industry. After discussing the effects of the President's energy program, the report analyzes the effects of increased energy prices on U.S. trade in manufactures, using the INFORUM price and input/output model as a basis. The report then focuses on the petrochemical industry, assessing the international competitive position of U.S. petrochemical trade and the potential trade impact of price increases in both the short and long term. Lastly, the report considers the possibility of exempting petrochemical feedstocks from the President's program. (GRA)

40977 (PB—255400) **Determination of refined petroleum product import fees.** (Pace Co. Consultants and Engineers, Inc., Houston, Tex. (USA)). Jul 1976. Contract FEA-CO-05-60451-00. 50p. NTIS $4.00.

This report presents the results of a study to determine the refined petroleum product import fee required to discourage new refining capacity from being built abroad for the purpose of exporting products to the United States East Coast. Additionally, import fees to eliminate imports from all areas except the Caribbean/Bahamas, and import fees to totally eliminate all imports from both new and existing refineries were also determined. U.S. mainland refineries on the Gulf Coast and East Coast were evaluated along with potential refineries in Africa, the Middle East, Canada, Hawaii, and the Bahamas/Caribbean area. Each evaluation included a determination of delivered crude oil cost, refining costs, and product shipping costs. (GRA)

40978 (PB—255920) **Weekly petroleum statistics reports, 1974—1975.** (Federal Energy Administration, Washington, D.C. (USA)). Aug 1976. 493p. (FEA/B—76/335). NTIS $12.50.

Collection of 46 issues of the Weekly Petroleum Statistics Report.

This is a complete collection of 46 issues of the Weekly Petroleum Statistics Report, beginning May 24, 1974 and ending April 4, 1974. This periodical was superseded by the Monthly Petroleum Statistics Report which is currently in publication. The weekly reports contain reporting by all petroleum refiners, bulk terminal operators and importers of their domestic petroleum receipts, imports, operating rates, production of each major petroleum product and stock levels. (GRA)

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 40851

40979 (PB—262001) **Preliminary environmental assessment of the CAFB. Final report, Aug 1975—May 1976.** Werner, A.S.; Young, C.W.; Bornstein, M.I.; Bradway, R.M.; Mills, M.T. (GCA Corp., Bedford, Mass. (USA). GCA Technology Div.). Oct 1976. Contract EPA-68-02-1316. 324p. (GCA-TR—76-18-G). NTIS, PC A14/MF A01.

The Chemically Active Fluid Bed (CAFB) process was developed by the Esso Research Centre, Abingdon (ERCA), England as a means to generate electrical energy from high sulfur, high metal heavy fuel oil. Fuel oil is fed continuously into a fluidized bed of limestone maintained at 870°C by preheated, substoichiometric air. The fuel oil entering the gasifier is vaporized, oxidized, cracked and reduced to produce a low-Btu, low-sulfur gas which is then burned in a conventional boiler. Sulfur contained in the oil initially forms various gaseous compounds which then react with the bed limestone to yield solid calcium sulfide. The sulfided lime is cycled to a regeneration unit where it is oxidized to produce CaO which is returned to the gasifier and SO_2 which is sent to a sulfur recovery unit. An additional feature of the CAFB process is that the gasifier bed material adsorbs vanadium, nickel and sodium contained in the fuel oil, thus limiting air emissions of these trace elements. The objective of this study was to conduct a preliminary environmental assessment of the CAFB. To attain these goals, a systematic evaluation of all waste streams from the CAFB was made and a process emissions inventory was compiled.

40980 **Thermal stability of sulfur compounds in heavy petroleum residual stocks.** Sabadash, Yu.S.; Provkina, R.G.; Kochetkova, T.V. (Groznyi Pet Sci-Res Inst, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **11**: No. 11-12, 938-941(1975).

The primary components of boiler fuels are vacuum tars from medium-sulfur and high-sulfur crudes. Until quite recently, such tars have been subjected to visbreaking, after which they are used directly as boiler fuels. The investigation reported in this paper was undertaken in order to curtail the discharge of sulfur compounds to the atmosphere. A number of different methods have been developed for desulfurizing petroleum residual stocks. The most widely used method is indirect hydrodesulfurization, in which the long residuum is vacuum distilled to take off as much overhead as possible; the vacuum gas oil is hydrotreated and then blended with the undesulfurized vacuum tar. In experiments, the thermal stability of the sulfur compounds present in heavy residual stocks, particularly the temperature conditions and degree of composition was studied. Results are presented and discussed. It is demonstrated that the maximum degree of noncatalytic decomposition of sulfur compounds in vacuum tars, within the required temperature limits, is at the 50% level. The sulfur compounds of the asphaltenes are typically the lowest in thermal stability; however, when these asphaltenes are cracked in the pure form, the maximum degree of decomposition of the sulfur compounds cannot be achieved, owing to the deficiency of hydrogen. 2 refs.

40981 **New tool combats SO_2 emissions.** Conser, R.E.; Anderson, R.F. pp 136-147 of In Petroleum derivatives. II. Current research. New York; MSS Information Corporation (1976).

After 10 years of concentrated development, the first commercial Shell flue-gas desulfurization (SFGD) unit is in commercial service. It went on stream this past summer at the Showa Yokkaichi Sekiyu refinery in Japan. The Japanese unit represents Shell companies' efforts to develop a commercial process with the following features: A dry acceptor that captures and regenerates SO_2 at about the same temperature, a reactor design in which flue gases are passed alongside the surface of the acceptor mass rather than through it, and process continuity by having two or more reactors alternate between acceptance and regeneration steps.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 40937, 41989, 41997

40982 (AD-A—027848) **Feature extraction techniques for classification and identification of spectral signatures. Technical report.** de Figueiredo, R.J.P. (Rice Univ., Houston, Tex. (USA). Dept. of Electrical Engineering). Apr 1976. Contract NAS9-12776. 5p. (EE-TR—7605). NTIS, PC A02/MF A01.

Some of the results obtained at Rice University on the extraction of features from spectral signatures for the purpose of classifying and identifying these signatures are described. (Author) (GRA)

40983 (AD-A—028785) **Shipboard oil-in-water monitor. Final report 24 May 74—30 Jun 76.** Bordeaux, J. (Beckman Instruments, Inc., Anaheim, Calif. (USA)). Jul 1976. Contract N00024-74-C-5445. 57p. (FR—2677-101). NTIS $4.50.

This report relates the work performed by Beckman to design, fabricate, and test an automated oil-in-water content monitor. A design concept was selected for development which contains the analytical features of the standard laboratory technique for measuring oil content in water. This involved solvent extraction of the oil and subsequent measurement of the infrared energy absorbed by the C-H bond using attenuated total reflectance. Automation was to be done by saturating a tape with solvent, impinging the oil/water sample onto the tape, allowing the oil to be extracted and migrate through the tape where, in contact with the surface of an internal

reflecting element, IR absorption would occur in proportion to the amount of oil present. Candidate tape materials and solvents were investigated. A cellulose acetate non-woven fabric and perchlorethylene were found to be a suitable combination. A laser source, dual beam system was designed around their use. Initial attempts were promising, and the system was redesigned to operate without solvent. A fully automated breadboard was assembled. The inherent capabilities of the system to measure oil in concentrations of 0-125 ppm were demonstrated.

40984 (AD-D—003269) **Controllable sorbent broadcaster.** Der, J.J. (Environmental Protection Agency, Denver, Colo. (USA)). 23 Aug 1976. 14p. NTIS, PC A02/MF A01.

According to the patent application, an apparatus is provided which can effectively broadcast oil sorbent material at a controlled rate uniformly over an oil slick for the purpose of removing the oil from the water's surface. The device comprises a rotating cylinder of wire mesh having an endless belt disposed therein. The endless belt contains compartments which are filled with the sorbent materials. When the top side of the endless belt is filled, the endless belt is rotated about an axis, thereby uniformly distributing the sorbent material within the wire mesh cylinder. The rotating wire mesh cylinder distributes the sorbent materials over the drop area at a controlled rate.

40985 (COO—2756-1) **Spreading, retention and clean-up of oil spills. Final report.** Wilson, M.P. Jr. (Rhode Island Univ., Kingston (USA). Dept. of Mechanical Engineering and Applied Mechanics). May 1976. Contract EY-76-S-02-2756. 130p. Dep. NTIS, PC A07/MF A01.

This study reviews and assesses the technology of oil spill spreading, retention and cleanup and proposes research needs in these areas. Sources of oil spills are analyzed and the difficulty of gathering meaningful statistics is discussed. Barrier technology is reviewed and problem areas analyzed. Natural and forced biodegradation and natural and chemical dispersion of oil spills are considered. Research recommendations are categorized under the following two headings (1) Preventive techniques and (2) Containment, Cleanup and Dispersion.

40986 (N—76-27720) **Investigation of size-dependent concentration of trace elements in aerosols emitted from the oil-fired heating plants.** Singh, J.J.; Sentell, R.J.; Khandelwal, G.S. (National Aeronautics and Space Administration, Langley Station, Va. (USA). Langley Research Center). Jul 1976. 29p. (NASA-TM-X—3401;L—10875). NTIS $4.00.

Aerosols emitted from two oil-fired heating plants were aerodynamically separated into eight size groups and were analyzed using the photon-induced X-ray emission (PIXE) technique. It was found that Zn, Mo, Ag, and Pb, and (to a lesser extent) Cd, have a tendency to concentrate preferentially on the smaller aerosols. All of these elements, in certain chemical forms, are known to be toxic. Zinc and molybdenum, although present in low concentrations in the parent fuels, show the strongest tendencies to be concentrated in finer aerosols. Selenium, previously reported to show a very strong tendency to concentration in finer fly ash from coal-fired power plants shows little preference for surface residence. Vanadium, which occurs in significant concentration in the oil fuels for both plants, also shows little preference for surface concentration. Even though the absolute concentrations of the toxic elements involved are well below the safety levels established by the National Institute for Occupational Safety and Health (NIOSH), it would be advisable to raise the heights of the heating-plant exhaust chimneys well above the neighborhood buildings to insure more efficient aerosol dispersal.

40987 (PB—254291) **Baseline study program, North Puget Sound. Biological oil impact literature review. Volume I. Text. Final report.** Buell, J.W.; Kacznyski, V.W. (Washington State Dept. of Ecology, Olympia (USA)). Oct 1975. 204p. (WA/DOE/BR—75/01). NTIS $7.75.

Sponsored in part by National Oceanic and Atmospheric Administration, Rockville, Md. Office of Coastal Zone Management. Prepared by Beak Consultants, Inc., Portland, Oreg.

Pertinent literature on the impact of oil upon the significant biological resources of Puget Sound is reviewed and analyzed. Possible effects of oil spills and spills of petrochemical products on the biota are considered. Interpretative data is summarized by organism and habitat. (GRA)

40988 (PB—257950) **Tomano oil spill in Casco Bay: environmental effects and cleanup operations.** (Environmental Protection Agency, Washington, D.C. (USA). Div. of Oil and Special Materials Control). Dec 1975. 284p. (EPA—430/9-75/018). NTIS $9.25.

This study was undertaken to determine the effects of No. 6 oil on marine communities of Casco Bay, Maine and to assess the effectiveness of containment and cleanup operations. Areas studied included rocky intertidal, intertidal mud, and sub-tidal benthic. Comparable control stations were chosen at Bailey Island and Orrs Island. Stations were analyzed for density and diversity of species as an indicator of stress. Sediments and selected biota were analyzed for No. 6 oil by gas chromatography. Results showed contamination at all stations, even those chosen as controls, indicating that the ultimate disposition of the oil did not correspond to sightings of surface slicks immediately following the spill.

40989 (PB—258412) **Environmental effects of Schuylkill oil spill II, June 1972.** (Environmental Protection Agency, Washington, D.C. (USA). Office of Water Program Operations). Dec 1975. 205p. (EPA—430/9-75/019). NTIS $7.75.

The fate and effects of a spill of six to eight million gallons of waste crankcase oil rerefined sludge into the Schuylkill River, Pa., in June of 1972 have been studied. The spilled oil contained high concentrations of heavy metals and aliphatic and aromatic hydrocarbons. The spill occurred during a flood, and riverbank trees were coated with oil. Levels of lead were higher in downstream trees; however, no direct permanent effects were noted. Levels of heavy metals in river waters remained below those set by the U.S. Public Health Service for drinking water supplies; however, higher concentrations of lead and zinc were observed downstream. Levels of lead in sediments were higher downstream. Concentrations of petroleum hydrocarbons in sediments were higher at downstream stations. Concentrations of lead in downstream benthic macrofauna were higher. (GRA)

40990 (PB—259097) **Assessment of hazardous waste practices in the petroleum refining industry. Final report.** Rosenberg, D.G.; Lofy, R.J.; Cruse, H.; Weisberg, E.; Beutler, B. (Jacobs Engineering Co., Pasadena, Calif. (USA)). Jun 1976. Contract EPA-68-01-2288. 369p. NTIS $10.50.

The report is a comprehensive review of hazardous waste generation and management practices within the petroleum refining industry. Nearly 625,000 metric tons (dry weight) of wastes were generated in 1974 by 247 refineries with a processing capacity of 14.2 million barrels per day. Waste streams emanating from individual refining process sources are characterized and described in detail. Following site visits and waste stream sampling at a representative group of sixteen refineries, a laboratory program of chemical analysis was carried out to identify potentially hazardous constituents of refinery wastes. Concentration levels of these constituents were measured, and hazardous wastes defined as those with any constituent with a concentration exceeding the average level in the natural soil environment. Oil is the principal hazardous substance in refinery wastes, representing approximately 110,000 metric tons per year. Metal constituents amount to 250 metric tons, fluoride to 812 metric tons, and phenol, cyanide, and benz-A-pyrene collectively to 6 metric tons. More than half of refinery wastes are removed by private contractors to ultimate disposal in offsite landfills or lagoons, however projections indicate a dramatic shift toward onsite disposal, particularly by landspreading and landfilling. Also anticipated is considerable waste reduction resulting from increased recycling, material reclamation, and product recovery. Some of the specific topics covered include: Characterization of the petroleum refining industry; The analytical program--(Criteria for identification of potentially hazardous wastes, Analytical methods and quality control procedures); Waste characterization; Treatment and disposal technologies; and Treatment and disposal costs. (GRA)

40991 (PB—259098) **The interrelationship of material toxicity, stream properties and quantity of spilled material in assessing the risk of hazardous material spills.** Jensen, P.A.; Hann, R.W. Jr. (Texas Agricultural and Mechanical Univ., College Station (USA). Environmental Engineering Div.). May 1976. 272p. (TAMU-SG—75-212). NTIS $9.00.

The current status of regulatory efforts for the bulk carriage of oil and hazardous materials is reviewed. The hazard posed to water resources is examined using the method of risk analysis. A weakness of the present regulatory efforts, namely that aquatic system properties and spill quantity are not considered, is identified. With risk defined as the product of spill probability and severity, a procedure is suggested to better quantify one element of water pollution risk--severity of spill impact. The procedure identifies two major parameters which affect spill impact, concentration of material in the water and the concentration at which the material causes acute toxic effects. The waterway relative dilution capacity quantification procedure is based on median discharge and considers the effects of longitudinal dispersion and the dynamics of fish mortality.

40992 **Identifying source of petroleum by infrared spectroscopy.** Lynch, P.F.; Brown, C.W. pp 227-237 of In Chemistry of petroleum processing and extraction. I. New York; MSS Information Corporation (1976).

Infrared spectra of over 50 samples of crude oils, fuel oils, and other petroleum products have been measured. Bands in the 650 to 1200 cm^{-1} spectral region were characteristic of each sample and can be used to identify the source of the sample. Computer analysis of absorptivities of 21 selected bands is used to match unknowns with the correct knowns by taking the ratios of known to unknown absorptivities. The method is demonstrated on laboratory samples and on a sample taken from an actual oil spill.

40993 Characterization and identification of spilled residual fuel oils by gas chromatography and infrared spectrophotmetry. Kawahara, F.K. pp 142-163 of In Chemistry of petroleum processing and extraction. III. New York; MSS Information Corporation (1976).

Analytical methods developed recently at the Analytical Quality Control Laboratory are described for the characterization and identification of heavy residual fuel oil pollutants found in surface waters. Identity can be made through use of each of the four GC techniques and infrared analytical procedure even though two different oils were spilled near the same area at about the same time. Infrared special differences reveal the approximate ages of the spills. A new electron capture detector gas chromatographic procedure designed for the diagnostic identification of heavier petroleum products shows excellent promise.

40994 Characterization of heavy residual fuel oils and asphalts by infrared spectrophotometry using statistical discriminant function analysis. Kawahara, F.K.; Santner, J.F.; Julian, E.C. pp 164-181 of In Chemistry of petroleum processing and extraction. III. New York; MSS Information Corporation (1976).

Spilled asphaltic materials and heavy residual fuel oils, because of their high molecular weights, complexity, and physical nature, cannot be readily identified to a source since these materials are not usually amenable to analysis by gas chromatography with flame ionization detector. The limiting difficulty is the inability to vaporize and to separate the high molecular weight components in the GC column. Infrared spectrophotometry is a useful technique for characterization of these materials. A combination of infrared spectrophotometry, data treatment, data transformation, and discriminant function analysis through computer assistance has resulted in effecting a more precise and accurate method of distinguishing between these two heavy petroleum products. An established statistical technique has been successfully applied to a recently developed infrared procedure for heavier petroleum products to provide a useful and powerful technique for classification of samples.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 41993

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 40985

40995 (N—76-28619) **SEASAT economic assessment. Volume 6: Arctic operations case study and generalization. Final report, Feb 1974—Aug 1975.** (ECON, Inc., Princeton, N.J. (USA)). 31 Aug 1975. Contract NASW-2558. 77p. (NASA-CR—148499;REPT—75-125-6B-V-6). NTIS $5.00.

The hypothetical development and transportation of Arctic oil and other resources by ice breaking super tanker fleets to the continental East Coast are discussed. The utilization of SEASAT ice mapping data is shown to contribute to a more effective transportation operation through the Arctic ice by reducing transportation costs as a consequence of reduced transit time per voyage. (GRA)

40996 (PB—255476) **Strategic petroleum reserve. Draft environmental impact statement.** (Federal Energy Administration, Washington, D.C. (USA). Office of Energy Resource Development). Jun 1976. 323p. (FEA/G—76/331). NTIS $9.75.

The subject of this EIS is the Strategic Petroleum Reserve program which was mandated by the Energy Policy and Conservation Act of 1975. FEA has identified three alternative storage systems for satisfying the objectives of the program. These alternatives, which consist of solution mined cavities in salt, conventional mines and aboveground tankage are discussed in this EIS. Prototype worst case facilities were developed to characterize these systems and to provide a basis for determining potential program impacts and resource requirements. (GRA)

40997 Model testing techniques in offshore pipelining. Clauss, G.; Kruppa, C. (Tech Univ, Berlin). *Erdoel-Erdgas Z.;* **91**: No. 5, 167-172(May 1975).

In modeling offshore pipelining the number of scaling laws is larger than can be fulfilled by adhering to complete geometric similarity. Therefore model pipe dimensions have to be selected on the basis of a compromise, the extent of which can only be assessed by deriving the appropriate scaling laws, from first principles. This was done in the early paragraphs of the article, adding some model tests in the subsequent ones. Recommendations are made for selecting model pipe material, geometry and possible liquid content.

PROPERTIES

REFER ALSO TO CITATION(S) 40942, 40948, 40960, 40962, 40964, 40965, 40966, 40967, 40968, 40969, 40970, 40992, 42145

40998 (BERC/PPS—77/2) **Aviation turbine fuels, 1976.** Shelton, E.M. (Energy Research and Development Administration, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). Apr 1977. 15p. Dep. NTIS, PC A02/MF A01.

Properties of some aviation turbine fuels marketed in the United States during 1976 are presented. The samples represent typical 1976 production and were analyzed in the laboratories of 16 manufacturers of aviation turbine (jet) fuels. The data were submitted for study, calculation, and compilation under a cooperative agreement between the Energy Research and Development Administration (ERDA), Bartlesville Energy Research Center (BERC), Bartlesville, Oklahoma, and the American Petroleum Institute (API). Results for the properties of 106 samples of aviation turbine fuels are presented for military grades JP-4 to JP-5, and commercial types Jet A and Jet B.

40999 Thermal conductivity of Upper Cretaceous Malgobek crude oil and narrow cuts from this crude. Bogatov, G.F.; Borodaev, G.S.; Gazdiev, M.A.; Grigor'ev, B.A.; Rastorguev, Yu.L.; Svidchenko, A.I. (M.D. Millionshchikov Pet Inst, Groznyi, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 1-2, 6-9(1976).

This paper presents results from experimental determinations of the thermal conductivity of Malgobek crude oil and narrow (10°C and 25°C) cuts from this crude, distilling over a temperature range from 60 to 550°C. The cuts were obtained by distilling a sample of Upper Cretaceous Malgobek crude whose characteristics are tabuiated. Thermal conductivity data are presented along with mathematical equations which have been derived for determination of the pressure dependence of the thermal conductivity of fractions. 8 refs.

41000 Lead traces titration in naphthas. Madec, M.; La Villa, F. (Inst Fr du Pet). *Rev. Inst. Fr. Pet. Ann. Combust. Liquides;* **31**: No. 4, 687-701(1976). (In French with English abstract).

Method of titrating alkyl leads in a naphtha capable of determining a lead content of 2 μg/l (i.e. approximately 2 ppb) is described. The lead is extracted from the organic phase by concentrated hydrochloric acid and ion-exchange softened water. Then it is complexed and extracted a second time by a suitable organic solvent. The end organic extract is titrated by atomic absorption. The purpose of the successive extractions is to concentrate the element to be titrated. At the same time, the organic-medium extraction increases the sensitivity of atomic absorption detection. 11 refs.

41001 Boundary lubrication of formulated C-ethers in air to 300°C. II. Organic additives. Jones, W.R. Jr. (Lewis Research Center, Cleveland). pp 10-24 of In Petroleum derivatives. I. Current research. New York; MSS Information Corporation (1976).

Friction and wear measurements were made on consumable electrode vacuum melted (CVM) M-50 steel lubricated with three C-ether (modified polyphenyl ether) formulations (organic acid additives) in dry (less than 100 ppM H_2O) and moist air relative humidity (RH) 50 percent at 25°C. Results were compared with those previously obtained with a fully formulated Type II ester and the C-ether base fluid. A ball-on-disk sliding friction apparatus was used. Experimental conditions were 1-kilogram load (initial Hertz stress, 1 x 10^9 N/m^2), a 17-meter-per-minute disk surface speed, a 25 to 300°C disk temperature range, and a 25-minute test duration. The three C-ether formulations yielded better boundary lubricating characteristics than the Type II ester under most test conditions. Formulation V (perfluoroglutaric acid boundary additive) (0.1 weight percent) exhibited lower or similar wear compared to the C-ether base fluid for most of the test conditions. In both dry (less than 100 ppM H_2O) and moist air (RH 50 percent at 25°C), formulations IV (polyacid boundary additive) and VI (phenylphosphinic acid boundary additive) (0.08 weight percent) yielded higher wear than the C-ether base fluid over the entire temperature range. In general, all C-ether formulations exhibited higher friction coefficients than the Type II ester from approximately 150 to 300°C. Lower or similar friction coefficients were observed for the formulations from 25 to 150°C. Formulation V (perfluoroglutaric acid additive) (0.1 weight percent) exhibited lower wear at low temperatures and higher wear at high temperatures when tested in moist air as compared to a dry air atmosphere. No moisture effects were observed with the other two formulations.

41002 Boundary lubricity studies: structure—activity correlations in alkylpyridines. Miller, A.H. pp 25-35 of In Petroleum derivatives. I. Current research. New York; MSS Information Corporation (1976).

Pyridine, several alkylpyridines and related aromatic compounds have been tested to determine their effect on the boundary lubricity properties of hydrocarbons. The results indicate that pyridine, as well as quinoline, is effective in reducing wear under sliding

contact, and indicate that the effectiveness of the alkyl derivatives is strongly influenced by the position of substituents on the pyridine ring. Mono-substituents in the ortho position caused reduced activity. Molecules with two substituents ortho to the ring nitrogen are ineffective. The role of substituent position has been interpreted in terms of steric interference which inhibits the approach of the molecule to the wearing surface.

41003 Investigation of anti-wear additives under various loads and at different sliding speeds. Sanin, P.I.; Lozovoy, Yu.A.; Shepeleva, E.S. pp 36-42 of In Petroleum derivatives. I. Current research. New York; MSS Information Corporation (1976).

The influence of some additives, mainly esters of arylphosphonic acids, on steel-steel friction in wide load and sliding speed ranges has been studied. In the presence of effective additives at sliding speed of about 6 to 8 m/s, the normal mode of friction (low friction coefficient) was observed in the whole range of applied axial loads up to 130 to 150 kg, the specific pressure being up to 35,000 kg per cm^2. At higher sliding speeds the increase of the loads at a definite limit causes a decrease of the efficiency of some additives (the increase of the friction coefficient and wear). When the applied load is further increased, the additive becomes effective again. This phenomenon has been observed with other active additives too and may be explained by the mechanism of chemical modification of surface friction. Under different friction conditions this modification can be of different nature.

41004 Complex esters as antiwear agents. Misra, A.K.; Mehrotra, A.K.; Srivastava, R.D.; Nandy, A.N. pp 53-61 of In Petroleum derivatives. I. Current research. New York; MSS Information Corporation (1976).

Diol centered complex esters using diethylene glycol, 1,3-butane diol, neopentyl glycol, polyethylene glycol (molecular weight 200 to 1000). l-phenoxy 2,3 propane diol as centered diols and sebacic acid as dibasic acid with outer monohydric alcohols as 2-ethyl hexanol, l-benzyloxy propanol-2 and methyl digol were prepared and assessed as antiwear agents in aviation turbine fuels, diesel fuels and light mineral oil. These types of complex esters, in general, were found to be effective antiwear agents.

41005 Service performance of steam-turbine oils: oxidation stability and the predominant causes of service degradation. Wilson, A.C.M. pp 62-90 of In Petroleum derivatives. I. Current research. New York; MSS Information Corporation (1976).

The evaluation of the oxidation stability of steam turbine oils was described by Wilson, 1964, who proposed test methods for evaluating new oils and for following the changes of oil stability in service. These have been used at C.E.R.L. since 1960, and this paper deals with the correlation of the results obtained and the performance of oils in service. The effects of changes in new oil stability and of turbine system environment are shown, and the effects of wear conditions, of water and of iron have been investigated in an attempt to eludicate the causes of deterioration in service.

41006 Determination of lithium stearate in sebacate-based lubricants by atomic absorption. Norwitz, G.; Gordon, H. pp 99-101 of In Petroleum derivatives. I. Current research. New York; MSS Information Corporation (1976).

An accurate method is proposed for the determination of lithium stearate in sebacate-based lubricants. The sample is treated with dilute hydrochloric acid and an extraction is performed with ethyl ether to remove di-isopropyl phosphite which would otherwise interfere by causing the subsequent precipitation of lithium phosphate or lithium metaphosphate. The aqueous extract is then evaporated to fuming with perchloric acid and the lithium is determined by atomic absorption.

41007 Determination of diisopropyl phosphite in sebacate-base lubricants. Determination of phosphorus in diisopropyl phosphite. Norwitz, G.; Galan, M.; Everett, M.E. pp 102-108 of In Petroleum derivatives. I. Current research. New York; MSS Information Corporation (1976).

Methods are proposed for the determination of diisopropyl phosphite in sebacate-base lubricants titrimetrically, gravimetrically, and spectrophotometrically. Organic matter is destroyed by treating with nitric and perchloric acids. In the titrimetric and gravimetric methods, ammonium molybdophosphate is precipitated, and empirical factors established by carrying potassium dihydrogen phosphate through the procedures are used. In the spectrophotometric method, the vanadomolybdophosphate color developed in a perchloric acid medium is used. All three methods yield results in reasonable agreement. Phosphorus in diisopropyl phosphite is determined by treating the sample with a mixture of bromine and nitric acid, evaporating to fumes of perchloric acid, and determining the phosphorus titrimetrically or gravimetrically.

41008 Spectrophotometric determination of antimony in sebacate-base lubricants by the iodide method. Norwitz, G.; Galan, M. pp 110-116 of In Petroleum derivatives. I. Current research. New York; MSS Information Corporation (1976).

A spectrophotometric method is proposed for the determination of antimony in sebacate-base lubricants by means of the yellow complex obtained with a potassium iodide-sodium hypophosphite reagent. Organic matter is destroyed by treatment with a mixture of sulfuric and nitric acids and evaporation to fumes of sulfuric acid. Barium sulfate is filtered off, the solution is diluted in a volumetric flask, one aliquot is taken for the blank, and another aliquot is taken for development of the color. Various factors affecting the development of the color were studied.

41009 Preferential adsorption in the lubrication process of zinc dialkyldithiophosphate. Barton, D.B.; Klaus, E.E.; Tewksbury, E.J.; Strang, J.R. pp 117-131 of In Petroleum derivatives. I. Current research. New York; MSS Information Corporation (1976).

Paper chromatography has been used in combination with neutron activation analysis to analyze the polar lubricity additive zinc dihexyldithiophosphate. This additive is shown to contain small but significant quantities of both phosphorous and zinc-containing polar impurities. Results of lubricity tests suggest that these polar impurities are adsorbed preferentially on a metal surface and therefore are available for the lubrication reaction in preference to the zinc dihexyldithiophosphate molecule itself. An acid phosphate-type compound is believed to be the active polar impurity controlling the wear behavior of zinc dihexyldithiophosphate. A chemical lubrication mechanism for zinc dialkyldithiophosphate is proposed. This lubrication mechanism involves the formation of a metal phosphate surface film. The agreement between this mechanism and lubrication data presented by previous investigators is discussed.

41010 Effect of lubricant extreme-pressure additives on rolling-element fatigue life. Parker, R.J.; Zaretsky, E.V. pp 146-166 of In Petroleum derivatives. I. Current research. New York; MSS Information Corporation (1976).

Rolling-element fatigue tests were conducted in the five-ball fatigue tester with a base oil with and without surface active additives. Three steel ball materials were investigated. The 12.7-millimeter diameter test balls were either AISI 52100, AISI M-50, or AISI 1018 steel. The test lubricant was an acid-treated white oil containing either 2.5 percent sulfurized terpene, 1 percent didodecyl phosphite, or 5 percent chlorinated wax. Nine combinations of materials and lubricant additives were tested at test conditions including a maximum Hertz stress of 800,000 psi, a shaft speed of 10,700 rpm, and a race temperature of 340 K. In general, it was found that the influence of surface active additives was detrimental to rolling-element fatigue life. The chlorinated-wax additive significantly reduced fatigue life by a factor of 7. Rolling-element surface distress was observed in some of the tests. These results suggest that the rheology of the base oil may have been altered by this additive. The base oil with the 2.5 percent sulfurized terpene additive reduced rolling-element fatigue life by as much as 50 percent. No statistical change in fatigue life occurred with the base oil having the 1 percent didodecyl-phosphite additive. The additives used with the base oil did not change the life ranking of bearing steels in these tests where rolling-element fatigue was of subsurface origin.

41011 Chemistry of petroleum processing and extraction. I. New York; MSS Information Corporation (1976). 238p.

Fifteen papers are included in the volume. A separate abstract was prepared for each paper. (JRD)

41012 Evaluation of carbon rod atomizer for routine analysis of vanadium in crude oil by atomic absorption spectroscopy. Chakrabarti, C.L.; Hall, G. pp 10-22 of In Chemistry of petroleum processing and extraction. I. New York; MSS Information Corporation (1976).

The Carbon Rod Atomizer (CRA) was evaluated for routine trace analysis of vanadium in crude oil by atomic absorption spectroscopy with a carbon (graphite) tube as a micro-furnace. Two crude oil samples were analyzed, both by standard addition and standard working curve methods, and the results confirmed by analysis with flame atomic absorption spectroscopy using a fuel-rich nitrous oxide-acetylene flame. Because of the relative involatility of vanadium at the temperature of the CRA, quantitative recoveries of vanadium in crude oil occur only when the vanadium content of the sample injected into the CRA does not exceed the limit of about 1×10^{-8} g. A sensitivity (weight/1 percent absorption) of 7.0×10^{-11} g and detection limit (signal-to-root-mean-square-noise equal to two) of 6.9×10^{-12} are reported.

41013 Determination of lead in petroleum and petroleum products by atomic absorption spectrometry with a carbon rod atomizer. Bratzel, M.P. Jr.; Chakrabarti, C.L. pp 23-30 of In Chemistry of petroleum processing and extraction. I. New York; MSS Information Corporation (1976).

The use of a carbon rod atomizer for the analysis of lead in petroleum and petroleum products is described. Variables affecting sensitivity studied include: type of lead salt and type of solvent for standard and sample preparation, hydrogen diffusion flame, choice of analytical wavelength and interferences. For the 217.00-nm line, a sensitivity of 1×10^{-11} g (absolute) and for the 283.31-nm line, a

detection limit of 2 x 10^{-12} g (absolute) are reported. Results of analysis of gasoline, used bunker heating oil, used jet engine lubricating oil, and crude oil for lead content are presented. An organic-to-aqueous solvent extraction system for lead is described.

41014 Determination of trace metals in crude oils by nonflame atomic absorption spectroscopy. Araktingi, Y.E.; Chakrabarti, C.L.; Maines, I.S. pp 31-54 of In Chemistry of petroleum processing and extraction. I. New York; MSS Information Corporation (1976).

Determination of trace metals, Co, Mg, Na, Sn, Cd, Zn, and Al in crude oil by nonflame atomic absorption spectroscopy with a modified carbon rod atomizer was studied. A standard addition method was developed for determination of these elements. The results obtained for three of the seven elements studied were confirmed by a conventional flame spectroscopic technique. Sensitivity and detection limit data were obtained for each element studied. Sensitivities ranged from 5.1 x 10^{-13} g for Mg to 1.5 x 10^{-10} g for Al. Detection limits ranged from 1.6 x 10^{-13} g for Mg to 2.8 x 10^{-11} g for Al. The effect of different sheath gases and a hydrogen diffusion flame on the absorbance was also studied. Sn and Al showed a relatively strong dependence on the hydrogen diffusion flame.

41015 Oxygen-bomb coulometric determination of vanadium in oils. Hetman, J.S. pp 55-58 of In Chemistry of petroleum processing and extraction. I. New York; MSS Information Corporation (1976).

A method for rapid determination of vanadium in oils is described. The sample is burned in a high-pressure bomb, V^5 is titrated coulometrically using a constant current automatic coulometer. A single determination is completed in 15-25 min. For the concentration range 20-50 ppM, 0.2 to 0.25 g of sample is required; for very low V-contents, 1 ppM and below, 1 g of sample is necessary. The accuracy and reproducility of the method are investigated, and typical coulometric titration curves are shown.

41016 Evaluation of a carbon-rod atomizer for routine determination of trace metals by atomic-absorption spectroscopy. Applications to analysis of lubricating oil and crude oil. Hall, G.; Bratzel, M.P. Jr.; Chakrabarti, C.L. pp 59-67 of In Chemistry of petroleum processing and extraction. I. New York; MSS Information Corporation (1976).

A carbon-rod atomizer (CRA) fitted with a "mini-Massmann" carbon rod was evaluated for routine analysis of petroleum and petroleum products for trace metal content by atomic-absorption spectroscopy. Aspects investigated included sensitivity, detection limit, effect of solvent type, and interferences. The results of analysis of oil samples with this technique were compared with those obtained by other techniques. Metals studied were silver, copper, iron, nickel, and lead. Sensitivity and detection limit values obtained with the CRA were similar to those obtained with the carbon-filament atomizer. Strong "solvent effects" were observed as well as interference by cations. On the basis of this study, design changes for the CRA are suggested, with the object of minimizing "solvent effects" and interferences, increasing the atomization efficiency, and increasing the residence time of the atomic vapor in the optical path of the instrumental system.

41017 Nature and distribution of sulphur compounds in Darius crude. Agrawal, B.B.; Rohatgi, H.S.; Gulati, I.B. pp 70-83 of In Chemistry of petroleum processing and extraction. I. New York; MSS Information Corporation (1976).

The distribution and type of sulfur compounds present throughout the boiling range of a crude oil has a great bearing on the processing of the different fractions of the crude. A systematic study of the type of sulfur compounds present in Darius crude oil distillates up to 350°C has been carried out. The concentrations of various sulfur compound groups were individually determined by chemical procedures covering potentiometric titrations as well as colorimetric methods. Quantitative data have been obtained for the distribution of following types of sulfur compounds: Elemental sulfur, hydrogen sulfide, mercaptans, total sulfides, aliphatic sulfides, reducible sulfur (disulfides) and homologues and isomers of these.

41018 Determination of trace amounts of total sulfur in light petroleum distillates. Honarkhah, L. pp 84-91 of In Chemistry of petroleum processing and extraction. I. New York; MSS Information Corporation (1976).

A sensitive method for measurement of trace amounts of total sulfur in light petroleum products is described. In this method nonolefinic hydrocarbons are reacted with activated Raney nickel and the addition of acid liberates H_2S which is absorbed in borax solution. The quantity of sulfur is determined iodometrically. Twenty eight samples containing sulfur from 0.01 to 100 ppM were analyzed by using this method. Average recovery of 100 +- 1.43 percent was obtained for sulfur concentration from 1 to 100 ppM. Results of analyses indicated that the method is accurate for measurement of total sufur in the range of 0.1 to 100 ppM and it can also detect sulfur content as low as 0.01 ppM. References of 38 methods for measurement of total sulfur in light petroleum distillates are given and the principle methods, time of analysis and precision are compared.

41019 Coulometric micro-determination of sulphur and chloride in mineral oils, deposits, and solvent-extraction residues. Hetman, J.S. pp 92-99 of In Chemistry of petroleum processing and extraction. I. New York; MSS Information Corporation (1976).

The paper describes the application of an automatic constant-current coulometer for the determination of sulfur and chlorine in mineral oils, deposits, etc. A few milligrams of the sample are burned in oxygen using a quartz tube heated at 1250°C. The combustion gases are absorbed in an aqueous solution of hydrogen peroxide resulting in the formation of sulfuric and hydrochloric acids. One aliquot of this solution is titrated with electrolytically generated OH'-ions, using a cell for acidimetric titrations. The titration is performed on the titration equivalent for the sulfur, thus the results give the sum of both acids expressed as micrograms of sulfur. The other aliquot of the solution is titrated in the cell for chloride titration, where hydrochloric acid is titrated with the electrolytically generated Ag-ions. As the titration is carried out on the same titration equivalent as above, the results also give chloride expressed as micrograms of sulfur. The difference in the two titrations corresponds to the sulfur content of the aliquot. The chloride content of the second aliquot is obtained by multiplying the titration results by the factor 2.22 of by repeating the titration using the titration equivalent for chloride.

41020 Microcoulometric determination of sulphur at sub-ppm levels using the standby technique. pp 100-102 of In Chemistry of petroleum processing and extraction. I. New York; MSS Information Corporation (1976).

Coulometric determination of S, Cl, and N at less than 1 ppM in volatile petroleum products is described. In this analytical method the sample combustion takes place simultaneously with combustion product titration. In order to separate combustion from titration, a standby position of the microcoulometer amplifier is used. In this position the microcoulometer regeneration circuit is not automatically activated by the sensor-reference electrode pair as is the case in the operate position, in which the instrument is normally used. The standby technique was applied in the determination of S at levels from 0 to 4 ppM. (JRD)

41021 Compound type separation and characterization studies for a 370° to 535°C boiling distillate of Gach Saran, Iran, crude oil. Dooley, J.E.; Hopkins, R.L.; Hirsch, D.E.; Coleman, H.J.; Thompson, C.J. pp 105-129 of In Chemistry of petroleum processing and extraction. I. New York; MSS Information Corporation (1976).

To process and use the heavy ends of petroleum effectively, the development of suitable separation and characterization procedures not currently available was required. A systematic procedure was developed by the Bureau of Mines using such techniques as isothermal and molecular distillation, chemical treatment, silica-alumina gel chromatography, gel permeation chromatography, and spectrometry. Using these techniques, the Bureau achieved a detailed separation and characterization of a 370 to 535°C distillate from Gach Saran, Iran, crude oil. Such a systematic procedure and the semiquantitative data resulting therefrom should be of value in selecting feedstocks and in optimizing petroleum processing operations.

41022 Compound-type separation and characterization studies for a 370° to 535°C distillate of Swan Hills (South Field), Alberta, Canada, crude oil. Dooley, J.E.; Hirsch, D.E.; Coleman, H.J.; Thompson, C.J. pp 131-159 of In Chemistry of petroleum processing and extraction. I. New York; MSS Information Corporation (1976).

An analytical procedure developed by the Bureau of Mines was applied to the separation and characterization of a 370 to 535°C distillate from Swan Hills (south field), Alberta, Canada, crude oil. Investigators determined the general characteristics of the crude oil by the Bureau's routine method for crude oil analysis. Suitable fractions were prepared for instrumental analyses by utilizing such techniques as isothermal and molecular distillations, chemical treatment, silica-alumina gel chromatography, and gel permeation chromatography (GPC). A detailed characterization of the 370 to 535°C distillate was possible by the application of GPC-mass spectrometry correlations and nuclear magnetic resonance spectrometry. Semiquantitative data based on mass Z series distributions were determined and are shown. The data will be valuable in developing future processing techniques and in calculating yields for converting high-boiling distillates into more useful energy forms.

41023 Compound-type separation and characterization studies for a 370° to 535°C distillate of Wilmington, Calif., crude oil. Hirsch, D.E.; Dooley, J.E.; Coleman, H.J.; Thompson, C.J. pp 161-188 of In Chemistry of petroleum processing and extraction. I. New York; MSS Information Corporation (1976).

A systematic procedure for separation, characterization, and semiquantitative analysis of high-boiling petroleum distillates was developed by the Bureau of Mines and applied to a 370 to 535°C distillate of Wilmington, Calif., crude oil. Separation procedures employed were isothermal and molecular distillation, chemical treatment, silica-alumina adsorption, and gel permeation chromato-

graphy. Characterization and analysis were accomplished by gel permeation chromatography correlations and mass and nuclear magnetic resonance spectrometry. These data should be useful in improving petroleum processing and utilization and in achieving the energy conservation inherent therein.

41024 Chromatography in the petroleum industry. Camin, D.L.; Raymond, A.J. pp 189-221 of In Chemistry of petroleum processing and extraction. I. New York; MSS Information Corporation (1976).

Chromatography as either an analytical technique or a bulk separation process has been an integral part of the petroleum industry since the start of the twentieth century. This article reviews the development of chromatographic procedures within the industry and the contributions of petroleum chemists to the advancement of modern chromatographic science. Today chromatography in many forms, i.e., gas-liquid, liquid-liquid, gas-solid, and liquid-solid, is widely used throughout the industry. ASTM standards based on chromatographic techniques are described and a number of typical chromatographic methods being used in petroleum laboratories to analyze and characterize refinery streams are discussed in detail.

41025 Nomograph for viscosity calculation in binary mixtures. Zanker, A. pp 222-226 of In Chemistry of petroleum processing and extraction. I. New York; MSS Information Corporation (1976).

A nomograph is presented which allows an instantaneous calculation of the kinematic viscosity of a binary blend of petroleum oils, on the basis of the known viscosities and weight fractions of separate components. An example drawn with a dotted line explains the use of the nomograph.

41026 Investigation of the activity of cutting oil additives. III. Oils containing both organochlorine and organosulphur compounds. Mould, R.W.; Silver, H.B.; Syrett, R.J. pp 97-107 of In Chemistry of petroleum processing and extraction. III. New York; MSS Information Corporation (1976).

Results of a study on the metal cutting activities of mineral oil blends containing mixtures of organosulfur and organochlorine compounds are reported. Mixtures containing 15 mg atoms percent chlorine, as either benzyl chloride or a commercial grade of chlorinated paraffin, Cereclor 51L, and 15 mg atoms percent sulfur, as dibenzyl disulphide or di-t-nonyl polysulphide, were used. Most of the blends were prepared using liquid paraffin as the base oil. In the tapping torque test, these blends generally gave a better performance than corresponding blends containing 30 mg atoms percent of either of the single components. In a drill life test, all of the mixed element blends were more efficient than those containing the single compound. In addition to the cutting tests, the four ball machine test similarly showed the mixed blends to have superior activities. That this was associated with the chemical activities of the additives was shown in a series of tests. The reactivities of the mixed component blends towards steel was greater than that of the single component blends, and it appears that this was associated with the production in the system of the iron salt of the other element. From this and other findings, reasons for the above-mentioned synergistic behavior are suggested.

41027 Mode of occurrence of trace elements in petroleum and relationship to oil-spill identification methods. Filby, R.H.; Shah, K.R. pp 182-205 of In Chemistry of petroleum processing and extraction. III. New York; MSS Information Corporation (1976).

Knowledge of the mode of occurrence of trace elements in crude oil is important in evaluating tagging or "fingerprinting" procedures. In this study thermal neutron activation analysis was used to measure Ni, V, Co, Hg, Fe, Zn, Cr, Cu, Mn, As, Sb, Se, Sc, Na and Ca. The Triga III-fueled reactor at Washington State University with a maximum thermal neutron flux of 1.2×10^{13} neutrons/cm^2 was used and the measuring system was a 65 cm^3 Ge(Li) detector and a ND-2200 4096-channel analyzer. Nuclear reactions used were (n,γ) except for the $^{58}Ni(n,p)^{58}Co$ reaction. A computer program (FOURIER) was used for spectrum analysis and data reduction. The method is nondestructive and samples as small as 50 mg can be analyzed. Analyses of 6 oils showed large variations in trace element contents even within a given oil well. All elements were shown to occur in oil-soluble form but Na, As, and Sb were shown to occur partly as water-soluble compounds. All elements were most concentrated in the asphaltenes of one crude oil studied. The ratios of asphaltene/crude concentrations varied from 3.4 (As)-23.6(Sb). Asphaltenes of a California oil were separated by gel-permeation-chromatography into 300 to 1,000, 1,000 to 4,000, 4,000 to 8,000, and 8,000 to 22,000 molecular-weight fractions. The 8,000 to 22,000 fraction was found only in the asphaltenes, except for Ni and Sb. Nickel was highest in the low-molecular-weight fraction of the asphaltenes due to the presence of Ni-porphyrin. Antimony showed decreasing values with increasing molecular weight. Nickel was shown to be present as both Ni-porphyrins and nonporphyrin Ni. In the low-molecular-weight fractions, the Ni was entirely Ni porphyrin. Porphyrins of elements other than Ni and V were not found. Arsenic and Sb occur partly in the oil as low-molecular-weight compounds, possibly alkyl or aryl arsines or stibines. The implications of the finds for tagging procedures are discussed.

STORAGE

41028 Microbiological corrosion of tanks in long-term storage of gas oil. Roberts, G.A.H. pp 206-217 of In Chemistry of petroleum processing and extraction. III. New York; MSS Information Corporation (1976).

There is considerable evidence in the literature for sulfate-reducing bacteria being responsible for corrosion in anaerobic conditions, and the mechanism of such action has recently been discussed. Conditions at the bottom of a large gas oil tank are ideal for these bacteria. Water dissolved in the gas oil or from the atmosphere condenses on the tank roof and then drips off through the gas oil to form pockets of water on the tank bottom. Suifates and organic material for the growth of the bacteria are available in sufficient quantities in the gas oil. If necessary, sulfates are supplied by aerobic sulfur bacteria which consume sulfur near the gas oil surface. Evidence collected during this work together with information published in the literature point to the conclusion that sulfate-reducing bacteria are responsible for the corrosion and leaking encountered in these storage tanks. Recommendations for the cleaning and repair of corroded and leaking tanks are included. Work is continuing with the object of developing a satisfactory method for the future prevention of such forms of attack on tanks.

41029 Microbiological corrosion of tanks in long-term storage of gas oil. II. Further bacterial studies and use of borax as a biocide. Roberts, G.A.H. pp 218-224 of In Chemistry of petroleum processing and extraction. III. New York; MSS Information Corporation (1976).

Previous work has established that sulfate-reducing bacteria have been responsible for pitting corrosion in the bottoms of tanks used in the long-term storage of gas oil. Further information on the occurrence and development of these bacteria has been collected. A suitable biocide has been selected to prevent future attacks and a method of application developed. Trials have demonstrated the absence of deleterious effects on the gas oil or materials of construction.

COMBUSTION

REFER ALSO TO CITATION(S) 40986

41030 (PB—254180) Flammability limits: thermodynamics and kinetics. Final report. Macek, A. (National Bureau of Standards, Washington, D.C. (USA). Center for Fire Research). May 1976. 28p. (NBSIR—76-1076). NTIS $4.00.

Extinction limits for both premixed and diffusion flames for n-alkanes and n-alcohols found in the literature are assembled. Several sets of theoretical flame temperatures corresponding to the limits are defined and presented. The implications of the view that flames fail to propagate at temperatures at which reaction rates become too low to overcome the dissipation processes are discussed. Equilibrium flame temperatures indicate that at lean limits the excess oxygen does not act merely as a diluent but takes an active part in promoting the kinetics of flame reactions. The burning-rate data and the results of ignition experiments are shown to be pertinent to the interpretation of flammability limits. Extinction characteristics of methane are shown to be atypical (compared to other alkanes and alcohols) and demand a special explanation. It is also shown that the assumption of thermodynamic equilibrium at the limits is unrealistic, so there is need for experimental temperature and concentration measurements in both premixed and diffusion flames. When the assumption of equilibrium is removed, the chemical kinetic considerations suggest a simple qualitative explanation of the limit phenomenon, based on the stipulation of incomplete combustion. Quantitative data are presented in support of this view. (GRA)

41031 Process of combustion of a mixture of natural, coking, and blast-furnace gases in a reversible combined burner with controlled spray. Akhmedov, R.B.; Talibdzhanov, Z.S.; Musaev, I.K.; Esin, M.P.; Moiseev, M.A. *Energomashinostroenie;* No. 5, 7-9(May 1975). (In Russian).

Results are presented of an experimental investigation of the title problem for different ratios of fuel components. Regularities of variation of gas components, temperature and heat fluxes falling on the waterwall along the length of the flame are established. The effects of the operating regime of the reversible burner on the quantitative and qualitative characteristics of these parameters are also determined. The burners of the investigated design ensure combustion of the gas mixture at low air excess after the superheater (1.03--1.06) and a higher efficiency of the boiler.

NATURAL GAS

REFER ALSO TO CITATION(S) 41600, 41646, 41647

RESERVES

REFER ALSO TO CITATION(S) 40916, 40917

41032 Analysis of the reliability of the results of calculation of gas reserves by the volumetric method. Berman, L.B.; Dmitrovskii, V.I.; Neiman, V.S. *Geol. Nefti Gaza;* No. 8, 27-32(1976). (In Russian).

The volumetric method of gas reserves calculation entails a systematic error of about 14%. The latter is the higher, the lower is the ratio between the mean values of the effective and the total capacities of the deposit. Systematic errors are higher in massive deposits, as well as in those occurring in carbonate deposits. The errors in gas reserves calculations by the volumetric method are due mainly to the faulty evaluation of the mean values of the parameters involved in the calculations, including the effective capacity (failure to take account of gas reserves in strata with an initial pressure gradient).

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 40918, 40919, 40922, 40923, 40925, 40926, 40929

DRILLING, PRODUCTION, AND PROCESSING

REFER ALSO TO CITATION(S) 40947

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 40757, 41601, 41638

41033 (PB—258 329) **Impact of natural gas curtailments on electric utility plants. Volume I. Text.** Brickhill, J.A. (Foster Associates, Inc., Washington, D.C. (USA)). Aug 1975. Contract EPA-68-02-1452. 162p. NTIS $6.75.

See also PB—258330.

This report analyzes the impact of natural gas curtailments on electric utility plants through the review of the curtailment plans of interstate pipeline, intrastate pipeline and gas distributors. This analysis determined the availability of natural gas through 1980 to 415 electric utility power plants, the alternate fuel burning capability of these plants and the impact of gas curtailments on the need for alternate fuels such as fuel oil and coal. The study results are presented in a two volume report: Volume 1 contains the narrative with pertinent findings and conclusions. (GRA)

41034 (PB—254629) **Consumption and conservation of natural gas. Highlight report, Volume XVIII. Monthly report.** (Opinion Research Corp., Princeton, N.J. (USA)). Sep 1975. Contract FEA-CO-04-50236-00. 12p. NTIS $3.50.

See also Volume 17, PB—254628.

This report is one of a series of studies dealing with general public behavior and attitudes toward energy conservation. Results of a survey of attitudes towards natural gas are given.

41035 (PB—258330) **Impact of natural gas curtailments on electric utility plants. Volume II. Schedules.** Brickhill, J.A. (Foster Associates, Inc., Washington, D.C. (USA)). Aug 1975. Contract EPA-68-02-1452. 148p. NTIS $6.00.

See also PB—258329.

This report analyzes the impact of natural gas curtailments on electric utility plants through the review of the curtailment plans of interstate pipeline, intrastate pipeline and gas distributors. Volume 2 contains the schedules or data summaries. (GRA)

41036 Gas industry development in Federal Republic of Germany in 1975. Plesser, N.; Goepner, W. (Bundesminist fuer Wirtsch, Bonn-Duisdorf, Ger). *Gas- Wasserfach, Gas-Erdgas;* **117**: No. 8, 321-346(Aug 1976). (In German).

Reduction in energy consumption is noted together with reduced gas supply. Natural gas, gasified coal, and petroleum gas economy are reviewed, and pipeline transported and locally manufactured gas supply is discussed. Investments and productivity are analyzed.

41037 Two decades of natural gas. Czerniejewicz, W. (Bundesminist fuer Wirtsch, Bonn, Ger). *Gas- Wasserfach, Gas-Erdgas;* **117**: No. 8, 347-349(Aug 1976). (In German).

Market statistics of the 1965-75 period are analyzed and problems of future development and some solutions are projected.

41038 Natural gas in the tenth five year plan in the USSR. *Gas Waerme Int.;* **26**: No. 1, 37(Jan 1977). (In German).

Short communication only.

ARTIFICIAL STIMULATION, PLOWSHARE, ETC.

REFER ALSO TO CITATION(S) 40938, 41989

41039 Effects of heat and radiation on Gasbuggy chimney gas. Bozak, R.E.; Taylor, R.W. pp 10-43 of In Chemistry of petroleum processing and extraction. III. New York; MSS Information Corporation (1976).

Chemical changes in the gas in the Gasbuggy chimney were observed for about six months following the explosion. Heat and radiation are postulated to cause this change. Samples of gas taken from the chimney at one month were heated and irradiated in the laboratory. Heat produced a decrease in H_2 and an increase in CH_4 concentration—trends that were observed in the chimney. On the other hand, irradiated samples of this gas showed a dose-related increase in H_2 and decrease in CH_4. Irradiation also caused about one-third of each gas sample to change into an oil.

41040 Gas quality and geochemical studies in gas-stimulation experiments. Taylor, R.W. pp 44-64 of In Chemistry of petroleum processing and extraction. III. New York; MSS Information Corporation (1976).

Gas produced following the Gasbuggy and Rulison gas-stimulation nuclear explosions had a different composition than the natural gas produced in the same areas before nuclear stimulation. The principal difference was the presence of substantial amounts of CO_2, CO, H_2, and H_2O in the post-explosion gas. There also were changes in ratios of hydrocarbons. Because CO_2 reduces the heating value of the gas, and steam presents a troublesome disposal problem due to the trace of tritium it carries, an understanding of the geochemical effects produced by these types of nuclear explosions is needed. Samples of gas-bearing shales were heated under a variety of conditions evolving CO_2 at temperatures as low as 500°C, even under a CO_2 pressure of 50 atm, due to reactions between fine-grained carbonates and silicates. In other experimental studies evidence was obtained that regions of high temperature (approximately 400°C), rather than radiation, caused the changes in gas composition observed in the Gasbuggy chimney during the 6-mo "shut-in" period. In looking ahead to the geochemical effects that occur when multiple explosions are used to form interconnecting chimneys, it is concluded that less CO_2 will be produced per unit yield than for a single explosion in the same rock. This is because the intensely heated rock is cooled rapidly by convecting gas before it can heat the adjacent rubble, which results in less rubble being heated hot enough to release CO_2. Steam production, however, will be greater in the case of multiple explosions than for single explosions because a higher fraction of the total yield is deposited as heat in the chimney, thus increasing the average chimney temperature. The average chimney temperature, and thus the steam pressure, increases as the distance between multiple explosions is decreased. The steam pressure will also increase as the depth of nuclear explosions is increased.

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 41049

41041 Ammonia leakage test. Irie, H.; Toyoda, H.; Suzuki, M.; Otsuka, Y. Tokyo; Nippon Kokan (1975). vp.

A series of experiments were performed to establish a test method for the tanks of LNG tankers. The test utilizes chemical reactions between ammonia gas and bromophenol to detect leakage. The impact, if any, of atmospheric temperature and humidity on the state of bromophenol was also studied and thus reliability of testing was ascertained. Bromophenol in a paint form was prepared to improve its working property. The test method can also be applied to land vessels including those related to nuclear power equipment and heat exchangers. 2 refs.

41042 International gas transmission. Brecht, C.A. *Energy Dig. (London);* **5**: No. 4, 10-14(Aug 1976).

Gas may be delivered to the European gas industry by pipeline or LNG carrier. Natural gas from the Soviet Union will certainly continue to be delivered by pipeline, but as far as Iranian gas is concerned, for example, either of those two alternatives may

be attractive. Gas from other countries of the Middle East might be transported to Western Europe by LNG carrier through the Suez Canal. Several interesting projects or the supply of very large quantities of gas (11-40*10^9 m^3/yr) by pipeline through Tunisia across the Mediterranean to Sicily and southern Italy or through Morocco across the Mediterranean to Spain and France have been developed recently. These plans are a technical alternative to increasing LNG supplies, at least in those countries which border on the Mediterranean. Two systems for the transportation of large quantities of gas over long distances are compared, LNG transportation by LNG tankers, and pipeline transmission. Some of the problems of controlling an international system for supplying gas are also discussed.

41043 Frigg onshore. McHugh, J.; Marris, J.H.S. (Br Gas Corp). *Energy Dig. (London)*; **5**: No. 4, 31-35(Aug 1976).

In 1971 the Petronord Group discovered gas in a structure in the northern basin of the North Sea some 350 km northeast of Aberdeen and this field, now known as Frigg, is believed to be one of the largest in the world. British Gas have had to construct major on-shore facilities and transmission pipelines to supply the gas into Scotland and northern England. The onshore facility at St. Fergus, Scotland, will receive gas from twin 800 mm sea pipelines 355 km in length. The design of the St. Fergus terminal is unique in British Gas in that it combines a natural gas reception terminal with a major compressor station. For transmission south the pressure of the gas received from the producers has to be raised to 67 bar. The two sea lines from the Frigg field have a total capacity of approximately 90*$10^6$$m^3$ and therefore the station has been designed on a phased basis to accommodate at least this quantity of gas in the long term. Some 125,000 operational horsepower will be required to raise the pressure of the 67*$10^6$$m^3$ of gas per day which is expected by 1980. Design details of the onshore pipelines, the problems encountered along their route, the compression stations, and the communication system are described.

41044 Experiences in using new steel types for high pressure gas lines constructing. Mikulla, W. (Hoesch-Roehrenwerke, Hamm, Ger). *Gas- Wasserfach, Gas-Erdgas;* **117**: No. 9, 365-370(Sep 1976). (In German).

Standards for welded pipes are reviewed. Properties of thermomechanically treated steels are investigated, and applications under Arctic conditions are discussed. 21 refs.

41045 Operational problems in gas piping system following conversion to natural gas. Schemel, R. (Oesterr Ver fuer das Gas und Wasserfach, Graz, Austria). *Gas, Wasser, Waerme;* **30**: No. 9, 271-276(Sep 1976). (In German).

Economical solutions to higher rates of damage and breakdowns in the Cologne gas supply system are discussed. Effect of material and maintenance practices on damage occurrence is investigated, and improved repair procedures are suggested.

41046 Natural gas pipeline through Lake Traun. Stadler, H.G. (Ferngas, Linz, Austria). *Gas, Wasser, Waerme;* **30**: No. 9, 277(Sep 1976). (In German).

Solution of technical problems in laying a 11.3-km-long double pipeline through the 196-m-deep lake bottom is presented. Pipes are made of steel and plastic insulated with a 2,5 m distance between the two lines. Lay barge use is described.

41047 Deep water laying of steel pipe-lines using free fall technique. Ursprung, H. *Gas, Wasser, Waerme;* **30**: No. 9, 278-280(Sep 1976). (In German).

Stress and pressure reduction to permissible levels obtained in laying a high-pressure natural gas pipeline under stormy conditions, is described. Calculation of forces and elasticity are explained, and preparatory measurements reducing actual laying time and underwater operations, are presented.

41048 Method for transporting liquefied natural gas. Rehder, R. (to Linde A.G.). German(FRG) Patent 2,449,442/B/. 21 Oct 1976. 5p. (In German).

3 figs.

The invention deals with a method of transporting the natural gas to the place of consumption by ship in subcooled state in a storage tank. The subcooling of the natural gas takes place by heat transfer with liquid nitrogen. This is obtained during transport either by reliquefaction or rectification of evaporated natural gas and is stored on the ship in storage tanks. The invention aims, amongst others, at reducing the flash gas production in the storage tank.

STORAGE

41049 Automatic welding for an LNG storage tank of 9% nickel steel. Kuriyama, Y.; Kohno, T.; Toyomasu, K.; Katayama, N.; Yokokura, M.; Kuriiyama, T.; Kurehashi, T. (Weld Res Inst). *IHI Eng. Rev.;* **9**: No. 3, 1-12(Jul 1976).

The application of the automatic TIG, automatic pulsed-MIG and submerged-arc welding processes to the vertical and girth butt joints of an aboveground LNG storage tank of 9% nickel steel was examined using the newly developed welding equipment, Hastelloy-type filler wires and low SiO_2, high basic bonded-type fluxes. The test results are summarized as follows: The amount of deposited metal obtained per day by the automatic TIG and automatic pulsed-MIG welding processes (both applied to the vertical butt joint) was, respectively, more than 1.6 and 2.5 times that by the shielded metal-arc welding process (approx. 3.7 kg/d). The automatic TIG welding process, though its deposition rate was not so large as that of the automatic pulsed-MIG welding process, was able to obtain more consistently welds of very high quality. Moreover, as the time for grinding bead surfaces can be remarkably reduced and the weld reinforcement shape controlled easier, the welding efficiency of the process is not inferior to that of the automatic pulsed-MIG welding process. The amount of deposited metal obtained per day by the horizontal submerged-arc welding process (D.C.R.P., filler wire: 2.4 mmphi) and the conventional submerged-arc welding process (flat position, filler wire: 3.2 mmphi) was, respectively, more than about 9 and 12 times that by the shielded metal-arc welding process. 5 refs.

OIL SHALES AND TAR SANDS

REFER ALSO TO CITATION(S) 40915

OIL PRODUCTION, RECOVERY, AND REFINING

REFER ALSO TO CITATION(S) 40941, 41639

IN SITU METHODS, TRUE AND MODIFIED

41050 Bitumen recovery from oil sands, using solvents in conjunction with steam. Farouq, S.M.; Abad, B.P. (Pa State Univ, University Park). *J. Can. Pet. Technol.;* **15**: No. 3, 80-90(1976).

Results of an experimental investigation of bitumen recovery from Athabasca oil sand, using solvents in conjunction with steam, are discussed. Most of the runs were carried out in a vertical tar sand pack, with restricted fluid entry near the bottom of the pack, simulating conduction-convection heating with gravity flow. A few runs were conducted in a large three-dimensional model of a five-spot configuration. It was found that bitumen recovery is determined by the type of the solvent, the volume used and the solvent placement. In many cases, cores were extracted and analyzed at the end of a run. These data permitted plotting of the temperature and bitumen saturation contours, which provided valuable insight into the prevalent recovery mechanism. 5 refs.

41051 Engineering aspects of processing oil shale by in situ retorting. Carpenter, H.C.; Burwell, E.L.; Sohns, H.W. pp 236-254 of In Chemistry of petroleum processing and extraction. II. New York; MSS Information Corporation (1976).

The Bureau of Mines is conducting in situ retorting experiments in Green River oil shale at a site near Rock Springs, Wyo. A hexagonal well pattern was designed, wells were drilled, and an evaluation of natural permeability was made. Fifty-one wells were each filled from a depth of 145 feet to 110 feet with approximately 420 pounds of explosive. The explosive in groups of two to four wells was simultaneously detonated to fracture the oil shale formation. This explosive fracturing induced multiple horizontal fractures that were confined to a zone from 124.5 to 129.0 feet below the surface. The oil shale was ignited with a propane burner, and combustion was continued using organic material in the formation as fuel. Sufficient surface area to sustain combustion at a satisfactory rate was not produced in this experiment by explosive fracturing; consequently, a hydraulic fracturing treatment was used to produce additional fractures. Combustion of shale in the hydraulic fracture system was started but also was limited by the availability of fuel. Only a small quantity of oil was produced during the entire experiment. Sufficient energy was released and left in the formation to retort about 2,000 tons of oil shale; however, from the observed temperatures and the amount of carbonate decomposition it was concluded that the energy was dissipated so widely that much less than 2,000 tons was heated to retorting temperature.

SURFACE METHODS

41052 Conversion of Athabasca bitumen. Gray, G.R. pp 19-70 of In Petroleum derivatives. II. Current research. New York; MSS Information Corporation (1976).

Product yields and inspections are presented for the four primary upgrading processes which have been proposed in the

various applications for commercial tar sands projects. The data show that Athabasca bitumen can be readily thermally visbroken, that the yields of coke are lower than would normally be expected from a naphthenic stock of this nature, and that high distillate yields can be obtained by hydrovisbreaking. The information presented illustrates the degree of flexibility inherent in each of the four processes.

REFINING

41053 Refining improvement of shale-oil naphtha. Barker, L.K.; Cottingham, P.L. pp 255-268 of In Chemistry of petroleum processing and extraction. II. New York; MSS Information Corporation (1976).

The purpose of this research was to determine how much, if any, improvement would be made by subjecting hydrogenated shale-oil naphtha to a catalytic reforming process. Preselected ranges of temperature and pressure within the commercial reforming ranges were chosen for investigation and other possible variables were held constant. All tests were made with a liquid hourly space velocity (LHSV) of 3 volumes of liquid feed per volume of catalyst per hour (V/sub f//V/sub o//h) and a hydrogen feed rate of 3,000 scf/bbl. Operating temperatures of 850, 875, and 900°F were used at pressures of 200, 400, and 600 psig. The greatest octane improvement in the naphtha was obtained at a temperature of 900°F and pressure of 200 psig. The reformed naphtha had a clear research octane number of 89, a liquid yield of 80 vol percent, and a yield-octane number of 71.1. The data indicate that a higher temperature could have produced a higher yield-octane number.

41054 Catalytic reforming of hydrogenated shale-oil naphtha. Barker, L.K.; Cottingham, P.L. pp 269-281 of In Chemistry of petroleum processing and extraction. II. New York; MSS Information Corporation (1976).

Naphtha from hydrogenated crude shale oil was suitable for established reforming processes. Good quality no-lead gasoline with an octane number of 89 was made from the naphtha. The octane number and low nitrogen and sulfur content of gasoline from shale oil compared favorably with regular gasolines. Regular grade gasolines now using lead additives have octane ratings near 94. The reforming feed was twice treated with hydrogen. Over 90 percent of the nitrogen and sulfur compounds (which usually inactivate the catalysts used in present reforming processes) was removed from the shale oil during the first hydrogenation step with a cobalt-molybdate catalyst. The relatively "clean" naphtha was then hydrogenated in the presence of nickel-tungsten catalyst, lowering the nitrogen content to 7 ppM of the gasoline and lowering the sulfur content to less than 0.001 wt. percent. Preselected ranges of temperature and pressure within the commercial reforming ranges were chosen for investigation, with other possible variables held constant.

41055 Hydrogenating shale oil at low space velocity. Frost, C.M.; Cottingham, P.L. pp 282-290 of In Chemistry of petroleum processing and extraction. II. New York; MSS Information Corporation (1976).

Crude shale oil prepared by gas-combustion retorting of Colorado oil shale was hydrogenated over a cobalt molybdate catalyst at an operating pressure of 1,000 psig, temperatures of 781 and 761°F, and liquid hourly space velocities of 0.10 and 0.05 V/sub o//V/sub c//h, respectively. The yields of total liquid products and the amounts of nitrogen and sulfur removed were comparable with those obtained at an operating pressure of 3,000 psig and a liquid hourly space velocity of 1.0 V/sub o//V/sub c//h. Approximately 1.5 times as much gasoline was produced at the lower pressure and space velocities.

41056 Methods for refining crude shale oil produced by in situ retorting. Frost, C.M.; Cottingham, P.L. pp 291-311 of In Chemistry of petroleum processing and extraction. II. New York; MSS Information Corporation (1976).

Crude shale oil produced during in situ retorting by the Bureau of Mines at Rock Spring, Wyo., was refined by three schemes. In the first, the crude oil was fractionated to raw naphtha and 400° F+ residuum. The residuum was hydrogenated over cobalt molybdate catalyst at 815°F and 1,000 psig. The blended raw and 160° to 400° F hydrogenated naphthas were hydrodenitrified and then catalytically reformed. The 400° F+ hydrogenated oil was catalytically cracked. In the second scheme, the crude was hydrogenated over nickel-tungsten catalyst at 800°F and 1,500 psig. The hydrogenated fractions were processed by methods used in the first scheme. The third scheme resembled the second but, prior to hydrogenation, the crude was "hydrostabilized" over cobalt molybdate at 500°F and 500 psig. Yields of reformate and cat-cracked gasoline as volume-percents of the crude, and research-method octane numbers (with 3 ml TEL) for the three methods were as follows: First method, 32 percent reformate, 90 octane; 19.5 percent cracked gasoline, 99.2 octane. Second method, 29 percent reformate, 81.1 octane; 21.3 percent cracked gasoline, 99.6 octane. Third method, 28.2 percent reformate, 86 octane; 28.7 percent cracked gasoline, 95.9 octane.

PURIFICATION

41057 Hydrodesulphurization of heavy gas-oils (650-975°F) derived from Athabasca bitumen. Soutar, P.S.; McColgan, E.C.; Merrill, W.H.; Parsons, B.I. pp 85-99 of In Chemistry of petroleum processing and extraction. II. New York; MSS Information Corporation (1976).

The hydrodesulfurization characteristics of three heavy gas-oils derived from Athabasca bitumen were determined and compared. The experimental work was undertaken in a bench-scale flow system at 2000 psi with the oil and hydrogen percolating up through a fixed-bed of cobalt molybdate catalyst, i.e., the system was operated in a bottom-feed, mixed-phase mode. The range of temperatures investigated was from 320 to 420°C at liquid hourly space velocities of 1, 2, and 3 with a hydrogen flow rate of 5000 scf/bbl. The reference feed stock was a gas-oil prepared commercially (500 to 850°F) from Athabasca bitumen by delayed coking. This was compared with two experimentally produced gas-oils (650 to 975°F) generated by the thermal and catalytic hydrocracking of Athabasca bitumen in a Mines Branch pilot plant. The reaction characteristics of the three gas-oils were found to be very similar. Products comparable to ASTM Grades 4 and 5 fuel oils containing 0.3 to 1 percent sulfur could be produced at all the space velocities investigated at low reaction temperatures 340 to 400°C. Slightly more light-ends were produced with the lower-boiling coker gas-oil than with the higher-boiling hydrocracked gas-oils but the amounts involved were not large. No significant catalyst deactivation was observed with any of the feed stocks over the 45 to 50 operating hours involved in any of the series of experiments.

41058 Comparison of bottom-feed and top-feed reaction systems for hydrodesulphurization. Takematsu, T.; Parsons, B.I. pp 100-118 of In Chemistry of petroleum processing and extraction. II. New York; MSS Information Corporation (1976).

The bulletin describes a bench-scale investigation of top-feed (mixed phase) and bottom-feed (liquid phase) continuous-flow systems for the hydrodesulfurization of a heavy "coker" gas-oil derived from the Athabasca bitumen. The specific gravity of the feed stock was 0.95 and the sulfur content was 3.4 wt. percent. The catalyst used was a commercially prepared mixture of the oxides of cobalt and molybdenum on alumina. In almost every respect the bottom-feed system was found to be more effective than the top-feed arrangement. The greater heat transferring capability of the liquid phase and the mixing effected by the bubbling hydrogen improved temperature control within the reactor considerably. More extensive desulfurization (at higher space velocities) was possible with the bottom-feed arrangement because of the longer residence time and improved temperature control. Fuel oil containing 1 percent sulfur could be produced at a space velocity of 3, at 355°C, and 2000 psi with only 3 to 4 percent hydrocracking to low-boiling fractions. Fuel oil containing only 0.5 percent sulfur could be produced at similar temperatures and pressures at a space velocity of 2.

41059 Hydrocracking of residual oils and tars. I. The effect of feed dilution on the thermal hydrocracking of Athabasca bitumen. McColgan, E.C.; Draper, R.G.; Parsons, B.I. pp 119-139 of In Chemistry of petroleum processing and extraction. II. New York; MSS Information Corporation (1976).

The paper describes recent work at the Fuels Research Center on the development of a hydrocracking process for upgrading heavy fuel oils and tars. Elements of hydrogenation and thermal cracking processes have been combined in a continuous flow system to pretreat the residuum and generate distillable streams more amenable to secondary catalytic hydrogen refining. The oil is heated slowly in the presence of hydrogen at 1000 psi, pumped once through a pipe reactor (without benefit of conventional catalysts), then separated into distillable and undistillable fractions. If properly regulated, sufficient hydrogenation occurs to prevent coke formation and substantially more distillate hydrocarbon is produced than in purely thermal coking. There is evidence to indicate that specific hydrocarbon fractions are acting as hydrogen transfer agents or homogeneous catalysts. A marked improvement in conversion and operability can be attained by diluting the feed material with relatively small quantities of low-boiling gas oils. Conversely, any factor which reduces the concentration of low-boiling hydrocarbon species in the pipe reactor (such as topping the feed or using a high gas flow rate) reduces conversion and enhances coking. The results of experiments made with bitumen from the Athabasca Tar Sands deposits are used to illustrate the numerous factors involved in attaining a balance of the conditions required to promote cracking and to minimize the accumulation of pitch deposits in the reaction system.

41060 Hydrocracking of residual oils and tars. II. The catalytic hydrocracking of Athabasca bitumen. McColgan, E.C.; Parsons, B.I. pp 140-170 of In Chemistry of petroleum processing and extraction. II. New York; MSS Information Corporation (1976).

The report describes a bench-scale investigation of the catalytic hydrocracking of the +975°F residuum in Athabasca bitumen with a view to a) increasing the yield of liquid hydrocarbon obtained compared with coking or purely thermal hydrocracking methods, and b) reducing the extent of on-site treatment required to produce relatively clean, stable distillates suitable for transmission to more central areas. The experiments were made in the liquid phase, using a conventional flow apparatus with a bottom-feed reactor and a commercially available cobalt molybdate catalyst. The range of pressures investigated was 1000 to 2500 psi at space velocities of 1.05 and 2.1. Comparing the yields of liquid product obtained by catalytic methods with those obtained by purely thermal hydrocracking, the permissible catalyst cost is estimated at 50 to 55 cents/barrel of feed.

41061 Hydrocracking of residual oils and tars. III. The effect of mineral matter on the thermal and catalytic hydrocracking of Athabasca bitumen. Soutar, P.S.; McColgan, E.C.; Parsons, B.I. pp 171-189 of In Chemistry of petroleum processing and extraction. II. New York; MSS Information Corporation (1976).

The report describes a bench-scale investigation of the effect of the concentration of residual clay and silt on the thermal and catalytic hydrocracking of bitumen separated from the Athabasca tar sands. The experiments were done in the liquid phase in a bottom-feed, continuous-flow apparatus at 1000 and 2000 psi, at liquid hourly space velocities of 1.05 and 2.1 with bitumen feed stocks containing 0.9 percent and 3.8 percent mineral matter. In the thermal hydrocracking process, the maximum conversion attainable and the yield of liquid distillate product were measurably higher with the bitumen containing the greater amount of mineral matter. The primary effect of the mineral matter is to suppress the coking and fouling reactions which limit the maximum operating temperature. The results indicate no significant catalytic activity attributable to the mineral matter for either the hydrocracking reaction or for desulfurization. In the catalytic process the residual clay and silt tended to foul the catalyst surfaces and the higher-mineral feed stock was found to be less reactive in every respect.

41062 Hydrocracking of residual oils and tars. IV. Catalyst deactivation with bitumens from Athabasca, Cold Lake, and Lloydminster. McColgan, E.C.; Soutar, P.S.; Denis, J.M.; Parsons, B.I. pp 190-202 of In Chemistry of petroleum processing and extraction. II. New York; MSS Information Corporation (1976).

The report describes an investigation of the effect of low concentrations of clay and silt (less than 1 percent) in bitumen feed stocks on catalyst deactivation in hydrocracking and desulfurization processes. The experiments were done in the liquid phase in a bottom-feed, continuous-flow apparatus at 2000 psi and a liquid hourly space velocity of 1.05 over a commercial cobalt molybdate catalyst. Feed stocks used were bitumens from the Athabasca tar sands (0.88 percent solids), Cold Lake (0.03 percent solids) and Lloydminster (0.07 percent solids). The extent of catalyst deactivation observed with each feed stock was essentially the same. In addition, no significant amounts of clay or silt were found in the catalyst bed at the conclusion of any series of experiments. From these observations it is concluded that finely dispersed clay and silt tend to wash out of the reaction system and, as such, are not the prime cause of catalyst deactivation.

41063 Hydrocracking of residual oils and tars. V. Surface-coated cobalt molybdate catalysts for hydro-treating. McColgan, E.C.; Soutar, P.S.; Rethier, M.A.; Parsons, B.I. pp 203-216 of In Chemistry of petroleum processing and extraction. II. New York; MSS Information Corporation (1976).

A surface-layering technique is described for preparing low-cost, powdered cobalt molybdate catalysts for hydrocracking and desulfurizing residual oils in liquid phase systems. A small quantity of peptized alumina is mulled on to the surface of 100 to 500-micron particles of alumina monohydrate (Boehmite). Concentrated solutions of salts of the active ingredients are dispersed in the peptized alumina, then the mixture is dried and calcined. Catalysts were prepared containing (over-all) concentrations of combined oxides of 13.0, 3.3, and 1.6 percent by weight. The hydrocracking and desulfurizing capability of each catalyst was determined with bitumen separated from the Athabasca tar sands at a liquid hourly space velocity of 1.05, and 2000 psi hydrogen pressure. The activity of the 13.0 and 3.3 percent catalysts were similar. The activity of the 1.6 percent combined oxides system was measurably less. The practical lower-limit of oxides concentration for catalysts prepared by the described method is about 3 percent by weight.

41064 Some observations on the hydroprocessing of a heavy crude oil. Speight, J.G. pp 231-234 of In Chemistry of petroleum processing and extraction. II. New York; MSS Information Corporation (1976).

Hydrocracking or hydrotreating are thermal (240 to 480°C) processes, usually involving high pressures (about 0.7 to 14 MN/m²), which are used with great flexibility in the petroleum industry for changing the character or quality of product material. The wide range of products possible from a hydroprocessing sequence is the result of combining the hydrogenation reaction with a variety of cracking catalysts which results in the conversion of a relatively low-grade feedstock into high-grade saleable products. Conditions of hydrocracking are proposed under which H reacts to produce definite structural entities within the bitumen which then act as H suppliers within the reaction matrix. The ability of the bitumen to produce desirable products depends not only on the amount and pressure of the gaseous hydrogen present at any one time but also, and perhaps more significantly, on the ability of certain structural entities to react with the hydrogen and act as hydrogen donors within the system. (JRD)

PROPERTIES AND COMPOSITION

REFER ALSO TO CITATION(S) 41011, 41019, 41639

41065 Investigation of the group and component composition of the alcohol-benzene extract of the combustible shale of the boltysh deposit of the Ukrainian SSR. Pobul, L.Ya.; Fomina, A.S.; Klesment, I.R.; Talvari, A.F. (Inst of Chem, Acad of Sci of the Est SSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **9**: No. 6, 113-119(1975).

In the reported experiments, the bitumoids extracted by organic solvents from the combustible shale of the Boltysh deposit are characterized by the presence of C_{24}--C_{31} alkanes mainly with odd numbers of carbon atoms. The high-molecular-weight fraction of the bitumoids contains a large amount of n-alkanes with C$sub 10$--C_{15} chains and a small amount of aromatic compounds. The alkyl groups in the structure of the kerogen of the shale and the fraction of high-molecular-weight bitumoids have similar compositions which are close to the composition of the normal paraffins of the majority of petroleum oils. 18 refs.

41066 Porous structure and specific surface of combustible shale. Lopachenok, L.V.; Belyanin, Yu.I.; Proskuryakov, V.A. (Lensovet Leningrad Technol Inst, USSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 1, 11-13(1976).

The porous structure of shale has been studied by mercury porometry; the shale has a structure of low porosity with the predominating radius at 200-600 A. The specific surfaces of shale and of enriched kerogen was measured by the low-temperature adsorption of radioactive krypton. The specific surface is determined by the amount of organic matter in the shale and the kerogen and, to a smaller extent, it also depends on their degree of comminution. 6 refs.

DIRECT USES AND BY-PRODUCTS

41067 (PB—254581-T/SL) Pilot plant for producing a mixture of crude dicarboxylic acids from shale. Proskulryakov, V.A.; Sokolov, V.N.; Yakovlev, V.I.; Gellis, Yu.K.; Belyanin, Yu.I. Translated from *Khim. Tverd. Topl.;* **5**: 109-111(1971). 7p. (EPA-TR—76-142). NTIS $3.50.

In the laboratories of the Leningrad Technological Institute (LTI) imeni Lensovet studies have been conducted investigating the oxidation of shale flotation concentrate in an aqueous-alkali medium by air oxygen. Results of these studies have led to the conclusion that it is practical and feasible to use shale as a raw material for producing dicarboxylic acids. Further works led to the creation of a design lay-out for this process. However, there is inadequate laboratory data for constructing large-scale production of dicarboxylic acids from shale. (GRA)

WASTE RESEARCH AND MANAGEMENT

41068 (PB—254728) Field compaction tests. Research and development program on the disposal of retorted oil shale-Paraho Oil Shale Project. Open file report. Holtz, W.G. (Development Engineering, Inc., Rifle, Colo. (USA)). 20 Feb 1976. Contract J0255005. 96p. NTIS $5.00.

Prepared by Woodward-Clyde Consultants, Denver, Colo.

This report contains information on the compaction characteristics of retorted (semiworks plant; direct heating method) oil shale when densified in the field by various types of commercial compacting equipment and the effects of (1) number of equipment passes, (2) thickness of layers, and (3) moisture addition. It also contains information on field densification of the retorted shale and particle breakdown occurring during the compaction processes plus a comparison of results from full-scale field tests and from standard A.S.T.M. laboratory compaction tests.

41069 (PB—254559-T/SL) Chemical composition and effectiveness of oil shale ash and cement kiln flue dust as liming fertilizers. Turbas, E.; Khiis, V.; Kuldkepp, P. Translated from *Sb. Nauch. Tr.*

Est. S-kh. Akad.; **69**: 81-96(1970). 17p. (EPA-TR—76-132). NTIS $3.50.

It seems that oil shale ash was even more effective than lime tuff and lake lime. On the basis of the investigations conducted by A. Khallik, the use of oil shale ash in acid soil was adopted. Today, only shale ash and clinker (cement) dust are employed in the Estonian SSR for liming acid soils. Of the total amount of employed lime fertilizers, more than 70% are made up by dust materials - dust oil shale ash and cement dust, although the use of the latter was only begun in 1964. The named waste products are ideally fine and are absolutely dry. This report covers its chemical composition and goes into field trials with different types of soils. (GRA)

FISSION FUELS

RESERVES

41070 (INIS-mf—3382) **1974 assessment of Canada's uranium supply and demand.** (Department of Energy, Mines and Resources, Ottawa, Ontario (Canada)). Aug 1975. 19p. (In English and French). Dep. NTIS (US Sales Only), PC A02/MF A01.

8 refs.

Canada's uranium resources, recoverable at prices up to $30/lb U_3O_8, were assessed. Measured reserves totalled 81 000 short tons U_3O_8. Domestic utilities are required to contract for 30-year fuelling requirements, in this case 92 000 short tons U_3O_8 for the 18 400 MWe expected in service by 1985. Canadian uranium production capability is expected to grow to 15 000 short tons U_3O_8 by 1984. The problem of defining indicated and inferred reserves is explored.

41071 (INIS-mf—3388) **1975 assessment of Canada's uranium supply and demand.** (Department of Energy, Mines and Resources, Ottawa, Ontario (Canada)). Jun 1976. 19p. (In English and French). Dep. NTIS (US Sales Only), PC A02/MF A01.

10 refs.

Canada's uranium resources recoverable for up to $40/lb U_3O_8 were estimated at 96 000 short tons U_3O_8 measured, 337 000 inferred. Approximately 21% of each producer's adjusted reserve will be required to provide the 30-year fuelling requirements of 81 000 tons U_3O_8 for the 14 700 MWe of nuclear capacity predicted for 1986. Resource figures are those recoverable with current technology.

41072 (PB—254896) **Uranium reserves, resources, and production.** (Energy Resources Council, Washington, D.C. (USA)). 15 Jun 1976. 18p. NTIS $3.50.

This paper summarizes the uranium information available from those Federal agencies which are ERC members and which have the competence to report on the uranium supply outlook. Two distinct questions are apparent: Is there enough uranium in the ground (domestic natural resources) to support a large national nuclear power program; Is uranium likely to be discovered, developed, and produced in sufficient quantities and in time to meet the demand. Available data indicate that there are sufficient economically recoverable uranium resources on which to base an expanding nuclear program. (GRA)

41073 **Uranium--the world picture.** *S. Afr. Min. Eng. J.;* **88**: No. 4118, 45, 47, 49, 53(Jul 1976).

The purpose of this paper is to examine the possible requirements for uranium in the future and to relate these to the available resources.

EXPLORATION

41074 (UCID—16911-76-4) **Hydrogeochemical and stream-sediment survey of the National Uranium Resource Evaluation (NURE) program: western United States. Quarterly progress report, October—December 1976.** (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Mar 1977. Contract W-7405-ENG-48. 18p. (GJBX—34(77)). Dep. NTIS, PC A02/MF A01.

Field work was completed for two orientation study areas in the Northern Rocky Mountain Province (Washington and Idaho), and planning is underway for three orientation studies in the southern Basin and Range Province (Arizona). Work continued on new office and laboratory facilities. Completion is scheduled for early in the second quarter of FY 1977. Planning and site selection were completed for reconnaissance surveys in west-central Utah and southern Nevada scheduled for the third quarter of FY 1977. Installation of the delayed-neutron counter and instrumental neutron-activation analysis system is nearly complete and the system will be operational next quarter.

41075 **Mineral exploration trends and developments in 1976.** Hood, P. (Geological Survey of Canada, Ottawa, Ontario). *Can. Min. J.;* **98**: No. 1, 8-9,12,14,17,20,22-25,27,29,32-35,37,39-40, 44-45,47(Jan 1977).

Worldwide geophysical exploration developments are very briefly described, with the article's major emphasis being on instruments available to prospectors.

MINING

REFER ALSO TO CITATION(S) 41124

FEED PROCESSING

REFER ALSO TO CITATION(S) 41124, 41125

41076 (IEA—416) **Recovery of uranium as a by-product of phosphorites from Brazilian northeast area.** Gonzaga, M.; Abrao, A. (Instituto de Energia Atomica, Sao Paulo (Brazil). Divisao de Engenharia Quimica). Apr 1976. 16p. (In Portuguese). Dep. NTIS (US Sales Only), PC A02/MF A01.

The extraction and recovery of uranium contained in marine phosphates of northeast Brazil were investigated by treating ores with hydrochloric acid. The average content of uranium in the ore was found to be about 0,03 percent which corresponds to the highest worldly known content of uranium in phoshorite. The solutions obtained in laboratory, by leaching the phosphorite with hydrochloric acid, contained 40-70mg U/1. A method to control the uranium solubilization was outlined. A liquid-liquid extraction of uranium from these liquors was performed using a mixture of 3 percent di (2-ethyl hexyl)-phosphoric acid and 2.2 percent TBP in Kerosene. An overall uranium recovery of about 85 percent was reached.

41077 (JAERI—1243) **Fluorination of uranium compounds by gaseous bromine trifluoride and a bromine-fluorine mixture.** Sakurai, T. (Japan Atomic Energy Research Inst., Tokyo). Mar 1976. 24p. Dep. NTIS (US Sales Only), PC A02/MF A01.

This report summarizes the studies of fluorination of uranium compounds by gaseous BrF_3 and a Br_2-F_2 mixture, which were carried out in Fluorine Chemistry Laboratory of JAERI in connection with the reprocessing method of nuclear fuels. Although thermodynamically more stable than F_2, BrF_3 has higher reactivity at relatively low temperatures: fluorination of uranium compounds can be carried out at 100° -- 200°C by using gaseous BrF_3. This fluorination temperature is lower than those of F_2, BrF_5, ClF and SF_4, and close to that of ClF_3. The usage of BrF_3 has however the drawbacks that it requires additional devices to heat the corrosive liquid and to remove Br_2 produced as a byproduct. In order to eliminate the difficulties indicated, a new method of fluorination was developed - the use of a Br_2-F_2 mixture. Addition of small amounts of Br_2 to the fluorine flow (about 6% in relation to the fluorine concentration) gives marked effects on the rate of fluorination.

41078 (JAERI-M—6405) **Adaptation of the continuous cold trap system of fluidized-bed to the fluoride volatility process.** (Japan Atomic Energy Research Inst., Tokyo). Feb 1976. 19p. (In Japanese). Dep. NTIS (US Sales Only), PC A02/MF A01.

A continuous cold trap system consisting of fluidized condenser and stripper has been evaluated with a view to adapt it to the Fluoride Volatility Process in establishing the continuous purification process without radiation decomposition of PuF_6. Its feasibility is shown by the test with UF_6-air. Necessary conditions for the cold trap, and performance of the 2-in. dia fluidized bed cold trap system are presented, and also a model of mist formation in the condenser.

41079 **Uranium plant opens.** *S. Afr. Min. Eng. J.;* 93(Oct 1976). Published in summary form only.

41080 **Blyvooruitzicht embarks on a sixteen million Rand expansion programme.** *Coal, Gold Base Miner. South. Afr.;* **25**: No. 1, 27-31(Jan 1977).

The separation processes applied to recover uranium oxides from slimes dams at Rand Mine's Blyvooruitzicht gold mine, Carletonville are listed. The items on which they expect heavy capital expenditure during the next 18 months are discussed.

ENRICHMENT

41081 **Chemical and ion exchange unit for a cascade of uranium isotope separation.** Calusaru, A.; Murgulescu, S. (Institutul de Fizica Atomica, Bucharest (Romania)). *Naturwissenschaften;* **63**: No. 12, 578-579(Dec 1976).

1 fig.; 1 tab.; 4 refs. Short communication only.

41082 **Isotopic separation by electrostatic filtration.** Devienne, F.M. (Nice Univ., 06 (France). Lab. de Physique Moleculaire des Hautes Energies). *C. R. Hebd. Seances Acad. Sci., Ser. B;* **283**: No. 15, 425-428(8 Dec 1976). (In French).

A brief description of a new process for enriching uranium is given. The method is based on the dissociation of a compound ion during a high energy collision with a neutral target molecule. The ions produced, isotopically different, have different energies and can be separated by retarding potential grids. After many experimental studies, some ten micrograms of enriched uranium, up to 4,1% of 235, were obtained in one operation.

FUELS PRODUCTION AND PROPERTIES

REFER ALSO TO CITATION(S) 41489

41083 (IAEA-CN—36/103) **Nuclear fuel in water reactors: manufacturing technology operational experience and development activities in the Federal Republic of Germany.** Holzer, R.; Knoedler, D. (International Atomic Energy Agency, Vienna (Austria)). 1977. 6p. (CONF-770505—138). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.4.-.T.1./05 1 table, 6 figs.

The nuclear fuel industry in the F.R. Germany comprises the full range of manufacturing capabilities for pressurized - boiling- and heavy water reactor technology. The existing manufacturing companies are RBU and Alkem. RBU makes natural and enriched UO_2-fuel assemblies, starting with powder preparation. Facilites to produce UO_2-Gadolinia and UO_2-ThO_2 fuel are also available. Alkem is manufacturing mixed oxide UO_2/PuO_2-fuel and -rods. Zircaloy cladding tubes are produced by NRG and MRW. This constitutes the largest single nuclear fuel manufacturing capacity outside the USA. The companies are interested in export and current capacity trends indicate some overcapacity caused by delays in plant schedules. Construction of a new fuel manufacturing plant in the FRG has been announced by Exxon. Supplementary to quality control in manufacturing an integrated quality assurance-system has been established between the reactor vendor KWU, fuel design and -engineering division, and the existing manufacturing companies for fuel and tubing. The operating experience with LWR and HWR fuel dates back to 1964/65 and proves good performance. No generic problems like densification or rod bow were encountered. Possible reasons for the small fraction of defective rods could be quickly identified by a fast feedback system incorporating a close cooperation between KWU and the utilities. KWU combines fuel development, hot-cell and poolside service facilities as well as fuel technology linking to manufacturing in one hand.

41084 (IAEA-CN—36/270) **Fabrication and irradiation performance of French HTGR fuel.** Moreau, C.; Ballagny, A.; Bujas, R.; Holder, J.; Ranc, R.; Soulhier, R. (International Atomic Energy Agency, Vienna (Austria)). 1977. 15p. (In French). (CONF-770505—173). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.6.-.T.1./01 6 figs.

The fabrication of fuel for high temperature reactors has been carried out in France either by using the techniques developed by General Atomic Company or by adapting European techniques to the characteristics of the American fuel. Currently, the principal efforts are directed towards fuel containing enriched uranium and thorium. Prior to this a large body of experience had been accumulated on the low enriched fuel of the type used in the Dragon reactor. Installations now in service permit us to fabricate, at realistic levels, all of the different parts comprising the fuel block. The kernels of fissile particles are made by loading of ion-exchange resin beads and conversion by thermal treatment. The fertile kernels are obtained by dry agglomeration of thorium powder. The coatings, of either BISO or TRISO design (pyrocarbon or pyrocarbon and silicon carbide), are deposited in a fluidized bed in a 127 mm diameter industrial furnace. The fuel rods (or compacts) are obtained by injecting a pitch loaded with graphite powder into a bed of particles. Another technique, which is now under development, consists of hot pressing the particles which have been mixed with resin impregnated graphite powder and then polymerizing them. In both cases, a final thermal treatment is carried out at 1800°C. Research and development in the machining of the prismatic graphite blocks has been performed by the Atelier Graphite at the Marcoule research center. A large program of irradiations has permitted testing of the individual fuel components followed by tests on complete fuel assemblies.

41085 (IAEA-CN—36/352) **Technological aspects of fuel manufacture for different power reactors.** Reshetnikov, F.G.; Verkhovykh, P.M.; Kotel'nikov, R.B.; Kushakovskii, V.I.; Makarov, V.M. (International Atomic Energy Agency, Vienna (Austria)). 1977. 14p. (In Russian). (CONF-770505—144). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.6.-.T.1./05 1 fig. Also available in English.

Successful performance of fuel elements and the entire power plant greatly depends on the quality of nuclear fuel used. The requirements imposed upon nuclear fuel are dependent on both the composition of fuel itself and the type of a reactor. Certain variables of the whole technological process including production of fuel and fuel cores should meet these requirements. The paper considers and correlates various technological factors that determine the quality of uranium oxide pellet cores and discusses the methods of production and use of granulated oxide fuel in vibration compacted fuel elements. Routes of production of mixed oxide fuel for fast reactors are compared and an analysis is made of the requirements placed by researchers upon mixed fuel. The second part of the paper deals with carbide and nitride fuel as a most promising one for fast reactors. Discussion and comparison is made of the methods for production of uranium and plutonium carbides and nitrides and Pu and U mixtures from oxides and metals, of the possible ways of improving the technology of carbide production from oxides and of the prospects of developing continuous technological processes for the production of carbide and nitride fuel including granulated carbide and nitride one. A brief assessment is made of the technology of production of nuclear fuel with specified properties for fuel elements to be used in different reactors.

41086 (IAEA-CN—36/386) **Integrated planning for a fuel industry with emphasis on minimum size to fabricate own fuel.** Kondal Rao, N.; Katiyar, H.C.; Rajendran, R.; Sinha, K.K.; Swaminathan, N.; Subramanyam, R.B.; Pande, B.P.; Krishnan, T.S.; Agarwala, G.C.; Chandramouli, V.A. (International Atomic Energy Agency, Vienna (Austria)). 1977. 7p. (CONF-770505—140). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.4.-.T.1./08 2 tables.

The Indian nuclear energy programme is based on the utilization of indigenous resources for the economic generation of power, developing its own know-how. In order to gain time, the first nuclear power station at Tarapur is a turn-key job based on enriched uranium fuel. Taking into consideration the established resources of uranium and thorium in the country, a strategy for nuclear power programme has been drawn up. The first phase is based on natural uranium fuel, the second phase on the recycle of plutonium and conversion of thorium and the third phase is the breeder system. This programme is specially significant for India in view of its vast resources of thorium. After the experience and confidence gained with the manufacture of metallic uranium fuel for the research reactors and about 40 tonnes of fuel for the initial loading of the Ratasthan Reactor, the fuel manufacturing programme within the country has been implemented to meet the entire initial and reload fuel requirements. The plant capacities are small compared to similar activities in developed countries. Further, by planning for an integrated fuel and component manufacturing complex, any draw-back in smaller scale of some of the operations is off-set. At the Nuclear Fuel Complex, set up on the above principles, production plants are in operation for the manufacture of reload fuel for the 400 MW Tarapur station, natural uranium oxide fuel, various Zircaloy components such as fuel sheaths, pressure tubes, calandria tubes, channels and various other Zircaloy components.

41087 (IAEA-CN—36/540) **Fabrication of nuclear fuel elements in Mexico.** Guerrero Morillo, H.L. (International Atomic Energy Agency, Vienna (Austria)). 1977. 7p. (In Spanish). (CONF-770505—137). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

7.1.-.T.1./06 2 figs., 3 tables.

The situation of the nucleoelectrical generation in Mexico by 1976 is described: two nuclear reactors under construction but no defined program on the type and start-up dates for the next power plants. However the existence of a general plan on nuclear power plants is mentioned, which, according to the last estimates reaches to 10,000 MW installed by 1990. The national intension, definitely expressed in the Law, is to supply domestic nuclear fuel to the power reactors operating in the country, starting with the first reload for the two BWR's at the first national station in Laguna Verde, which will be required at the end of 1981 and of 1982, respectively. Mexico has to adopt a strategy to follow in respect to fuel elements fabrication. The two main options are analyzed: 1. To delay the local fabrication until a National Nuclear Program may be defined, meanwhile purchasing abroad the necessary reloads and initial cores; and 2. To start as soon as possible the local fuel elements fabrication in order to supply fuel for the first reload of the

first unit of Laguna Verde, confronting the economical risks of such posture with the advantages of an immediate action. Both options are analyzed in detail comparing them specially under the economic point of view. Present information from possible suppliers of design and manufacturing licences are used to analyze all cases.

41088 (IEA—405) **Development of a routine method for the determination of mean crystallite dimensions in nuclear materials by X-ray diffraction line broadening. An application example using U_3O_8 microspheres.** Imakuma, K.; Sato, I.M.; Cretella Neto, J.; Costa, M.I. (Instituto de Energia Atomica, Sao Paulo (Brazil). Divisao de Engenharia Quimica). Mar 1975. 15p. Dep. NTIS (US Sales Only), PC A02/MF A01.

A method for mean crystallite size determination by X-ray diffraction line broadening was established. Both step-scanning and methods were extensivly tested and the precision of the data obtained as a function of the crystallite size is discussed. Emphasis is given to our contribution in order to eliminate instrumental effects as well as K sub(α_1)/Ksub(α_2) doublet effect upon line broadening. Instrumental correction was performed with a monocrystalline Si sample having mean crystallite size well above 13,000 A improving the accuracy of experimental data. Ksub(α_2) and Ksub(α_2) peaks determined instead of taking it for granted as 5. The mean crystallite dimension of U_3O_8 was calculated and the results show the dependence of this parameter on the quality of the microspheres.

41089 **Plane strain fracture toughness of unalloyed alpha phase plutonium.** Beitscher, S. (Rocky Flats Plant, Rockwell International, Golden, Colorado, USA); Ludemann, W.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). pp 719-727 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The plane-strain fracture toughness (Ksub(Ic)) of unalloyed alpha-phase plutonium was determined by tests on fatigue-precracked compact-tensile specimens. The values of Ksub(Ic) were 11.6 Ksi√in. at -34 C, 10.7 Ksi√in. at 25 C, and 9.6 Ksi√in. at 74 C (12.8 MPa√m at 239 K, 11.8 MPa√m at 298 K, and 10.6 MPa√m at 347 K). Compared with more common metals, alpha-phase plutonium has an extremely low toughness. The increase in Ksub(Ic) with increasing temperature was not expected.

SPENT FUELS REPROCESSING

REFER ALSO TO CITATION(S) 41109, 41111, 41393, 41486, 42013

41090 (AERE-R—8509) **Possible use of carboxylic acids for U/Pu separation in nuclear fuel reprocessing.** McKay, H.A.C.; Miles, J.H.; Park, H.S. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Oct 1976. 35p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Available from H.M. Stationery Office, price Pound1.50.

Existing methods for separating U/Pu all have drawbacks. An alternative is to use acetic or formic acid, which can considerably reduce the extractability of Pu(IV) into TBP/OK, while still permitting extraction of U. Formic has an advantage over acetic acid, because it can be destroyed after use by reaction with nitric acid. Basic distribution data have been obtained for the carboxylic acids themselves, and for U and Pu in a wide range of mixtures of HNO_3 and the carboxylic acids, using 20% TBP/OK. Possible flowsheets for U/Pu separation have been designed on the basis of these data and tested in a mixer-settler bank. It has proved difficult to design a satisfactory flowsheet, largely because the carboxylic acids do not complex Pu(IV) strongly enough. The flowsheets tested give insufficient separation and require rather close control of flowrates.

41091 (CEA-CONF—3615) **Pulse columns: advantages and selection criteria.** Rouyer, H. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Genie Radioactif). 1976. 17p. (In French). (CONF-7605151—1). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Technical meeting mining and mineralurgy session; Caen, France (11 May 1976).

Pulse columns and the pulsation techniques used are described. The parameters which affect the capacity and the efficiency of the columns are discussed.

41092 (CEA-CONF—3683) **First experiments on the reprocessing of fast reactor fuels in France.** Miquel, P.; Boudry, J.C. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Div. de Chimie). 1976. 13p. (CONF-760823—10). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Meeting of the American Institute of Chemical Engineers; Atlantic City, New Jersey, United States of America (USA) (27 Aug 1976).

The Purex process has been improved and extensively tested by processing irradiated fuels from Rapsodie and Phenix in the pilot facilities of the Commissariat a l'Energie Atomique. The performance of this process, particularly improved by adopting specific dissolution, clarification and extraction conditions, is now considered to be adequate and large scale technological tests are going to be carried out to adapt it to the unit that will have to process the fuels of the first Super Phenix reactors.

41093 (GA-A—14304) **Thorium utilization program. Quarterly progress report for the period ending February 28, 1977.** (General Atomic Co., San Diego, Calif. (USA)). Mar 1977. Contract EY-76-C-03-0167-053. vp. Dep. NTIS, PC A13/MF A01.

General Atomic Thorium Utilization Program activities progressed on schedule during the quarter, with continuation of the head-end reprocessing equipment testing program. Individual testing of the tertiary, oversize crushers and the screener was completed. Preparation of the equipment for testing as a system is under way. Tests on the tertiary crusher revealed no operating problems. No material holdup areas or bypass of the crushing cavity were detected. The initial issue of a functional level diagram for the Fuel Element Size Reduction System has been prepared for preliminary review. Heat transfer coefficients were calculated from data obtained in six 0.40-m primary burner heatup runs. Six runs were made on the 0.20-m primary burner. Other significant 0.20-m burner work included fabrication and initial testing of an electrical resistance probe bed level sensor and preliminary heat transfer design calculations for determining the cooling requirements to maintain the recycling fines cyclone exit temperature at approximately 500°C. The conceptual design of the engineering-scale dissolver-centrifuge for incorporation into the head-end line was completed. Three solvent extraction feed adjustment runs were completed. Two of the runs were representative of the continuous intercycle concentration step. The other run was a continuous operation which utilized leacher product as feed. Progress with dry solids handling component and system testing continues. Efforts were focused on completion of the HET fuel shipping conceptual design report, development of detailed costs, and identification of all system interfaces. The Reprocessing Flowsheet Review and Materials Balance Study of reprocessing head-end and off-gas treatment systems is in technical review.

41094 (IS-M—25) **Simulation for control synthesis of a plutonium—uranium extraction process.** McCutcheon, E.B.; Burkhart, L.; Felt, R.E. (Ames Lab., Iowa (USA)). Apr 1975. Contract W-7405-ENG-82. 8p. (CONF-750411—96). Dep. NTIS, PC A02/MF A01.

From European nuclear conference; Paris, France (21 Apr 1975).

A three column extraction process for scrap recovery using plutonium recycle has been developed and operated by Atlantic Richfield Hanford Company at Richland, Washington. A simulation study was undertaken to investigate the precise column operation and to facilitate the development of a column control strategy to maintain high standards of plutonium-uranium partitioning with minimum hydroxylamine and hydrazine consumption despite a wide range of potential fieldstream disturbances. (LK)

41095 (JAERI-M—6392) **Fluorination process studies of plutonium dioxide by fluid-bed.** (Japan Atomic Energy Research Inst., Tokyo). Feb 1976. 48p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

As the first stage towards establishing the F_2 two-step fluorination process for stable recovery of plutonium, the fluorination process has been studied with PuO_2 and UO_2 powder in the 2"phi fluid-bed. Fluorination process characteristics and related problems were clarified. This report describes outlines of experimental system and its design philosophy, overall operating test with UO_2, fluorination studies of PuO_2, analysis with a neutron process monitor and powder sampling.

41096 (JAERI-M—6393) **Development of F_2 two-step fluorination process for non-aqueous reprocessing.** (Japan Atomic Energy Research Inst., Tokyo). Feb 1976. 27p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

To establish the F_2 two-step fluorination for stable and high recoveries of plutonium, the fluorination process has been studied with the simulated fuel to a FBR containing UO_2 - PuO_2 and non-radioactive fission products (FPs) in the 2"phi fluid-bed. The process principle was demonstrated and the effect of FPs on fluorination of U and Pu and the possibility of reducing the Pu loss could be clarified. The feasibility of separating PuF_6 from UF_6 onto UO_2F_2 by adsorption, was also indicated.

41097 (JAERI-M—6487) **Description of an engineering-scale facility for uranium fluorination studies.** Yagi, E.; Saito, S.; Horiuchi, M. (Japan Atomic Energy Research Inst., Tokyo). Mar 1976. 41p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

In the research program of power reactor fuel reprocessing by fluoride volatility process, the engineering facility was construct-

ed to establish the techniques of handling kilogram quantities of fluorine and uranium hexafluoride and to obtain engineering data on the uranium fluidized-bed oxidation and fluorination. This facility is designed for a capacity of 5 kg per batch. Descriptions on the facility and equipment are given, including design philosophy, safety and its analysis.

41098 (JAERI-M—6488) **Technical experiences in an engineering-scale facility for uranium fluorination studies.** Yagi, E.; Maeda, M.; Miyajima, K.; Kagami, H. (Japan Atomic Energy Research Inst., Tokyo). Mar 1976. 76p. (In Japanese). Dep. NTIS (US Sales Only), PC A05/MF A01.

In the research program of power reactor fuel reprocessing by fluoride volatility process, an engineering-scale facility for uranium fluorination has been operated batchwise and semi-continuously since 1969 in Fuel Reprocessing Laboratory, JAERI, to establish the techniques of handling kilogram quantities of fluorine and uranium hexafluoride and to obtain engineering data on the uranium fluidized-bed fluorination. The experiences gained with the facility are described, giving some evaluations and recommendations for the equipment design, its performance and operation of the system.

41099 (ORNL/TM—5566) **Nuclear fuel dissolution and rinsing studies using a continuous rotary dissolver.** Holland, W.D.; Reiser, C.O.; Heimdahl, R.B.; Groenier, W.S. (Oak Ridge National Lab., Tenn. (USA)). Mar 1977. Contract W-7405-ENG-26. 45p. AT.

An experimental study of a small-scale continuous rotary dissolver is described. The unit is essentially a 1-ft (0.305-m)-diam horizontal drum divided axially into five 5-in. (0.13-m)-wide compartments. Solids are periodically advanced from compartment to compartment while liquid dissolvent flows countercurrent to the solids. Experimental runs were made to determine rinse efficiencies and the amount of solids that accumulated within the unit. Metal and ceramic powders were used to simulate insoluble fines, and water was used to simulate the liquid dissolvent. The unit was further tested by dissolving UO_2 from metal hulls with HNO_3. The capability of the dissolver for processing large metal pieces (representing sheared pieces of shroud) was also examined. Results indicate satisfactory overall performance of the dissolver unit. A few minor operating problems were found, but these appear to be easily correctable.

41100 Plant for the liquid-liquid extraction of radioactive substances. Johannisbauer, W. (to Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). German(FRG) Patent 2,353,233/C/. 16 Jun 1976. 5p. (In German).

1 fig.

A plant for the liquid-liquid extraction of radioactive substances in aqueous solution with extraction solvents or detergents is described which has a gas-pulsed mixing chamber and a separating vessel connected at the outlet of it. At least one pulse gas-pipe connected to a gas pump and directly immersing into the solution of the mixing chamber with its free end is provided for. Mixing chamber, separating vessel, and gas pump are all enclosed by a radiation shield. A gas-jet pump with a suction space and a driving-gas pipe is used as gas pump, the pulse gas-pipe feeding into the suction space of the gas-jet pump and the driving-gas pipe being connected to a pressure-gas pipe by means of a controllable isolating value mounted outside the radiation shield.

41101 ^{129}I as an example: problems of reprocessing. Keller, C. *Nachr. Chem. Tech.;* **24**: No. 18, 445-447(Sep 1976). (In German).

1 tab.

The article gives a short survey of the natural occurrence and the production of ^{129}I by spontaneous fission of ^{238}U and by neutron-induced fission of ^{235}U in the reactor. The ^{129}I pathway through the food chain to its uptake by the thyroid (critical organ) is described. By means of theoretical data, it is shown that the release of ^{129}I with the off-gases from reprocessing plants for nuclear fuel elements will cause no ecologically harmful concentrations in the neighbourhood of these plants. On the other hand, the concentrations will be high enough for all necessary studies on the concentration and degradation of this radionuclide.

41102 Reprocessing of fission material: a look at the European situation. Verkerk, B. *Atoomenerg. Haar Toepass.;* **18**: No. 12, 322-324(Dec 1976). (In Dutch).

Reviews the present status of the factories of United Reprocessors, which is made up of the French CEA, the British BNFL and the German GWK, and of other installations like the Eurex plant in Italy and Atelier AT1 at La Hague. Predicts the output from various countries over the next few years. Plants now being planned will have to satisfy stiffer requirements, partly through technical progress and partly because of more stringent environmental standards. Discusses the latter point in more detail.

41103 Use of neutron poisons for criticality safety in reprocessing plants. Wuerz, H. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik). *Atomwirtsch., Atomtech.;* **22**: No. 1, 33-36(Jan 1977). (In German).

4 figs.; 5 tabs.; 6 refs.

Criticality evaluations have been made for the dissolver of a reprocessing plant for oxidic LWR fuel elements. It is assumed to be critically unsafe for lightly burned-up fuel elements and to be suited for a transfer to a critically safe condiction by adding a minimum amount of poison. Besides gadolinium, boron and cadmium have also been studied as homogeneous neutron poisons, and the possibility of heterogeneous poisoning is discussed.

TRANSPORT AND STORAGE

41104 (IAEA-CN—36/23) **Waste management implications of irradiated nuclear fuel storage.** Larrick, A.P.; Schneidmiller, D. (International Atomic Energy Agency, Vienna (Austria)). 1977. 8p. (CONF-770505—229). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.2.-.T.2./06 3 tables, 1 fig.

Irradiated nuclear fuel is stored underwater in large recirculating basins prior to reprocessing in chemical separations plants. A small number of the fuel rods contain minor defects which allow fission products to seep into the basin water. Freshly discharged fuel releases short half-lived radioiodine which presents exposure and airborne release problems on a short-term basis but does not impose significant long-term waste management problems. After a reasonable decay period, the major radionuclides present are ^{137}Cs, ^{144}Ce, ^{90}Sr, ^{3}H, and $^{239/240}Pu$. Each of the radionuclides imposes specific waste management problems which require individual consideration in their control, packaging and shipment, and permanent disposal. These considerations are reviewed in this paper for general industry practices and specific illustrative examples are presented. Cesium-specific exchange media are employed at basins where demineralized water is not employed; these media operate for very long periods of time since they are not depleted by the normal dissolved non-radioactive water impurities. The resins are either buried when depleted or regenerated and the regeneration solutions concentrated for burial. Resin run lengths are usually determined by ionic or radiochemical depletion of the resin or in some cases by limiting radionuclide concentrations specified by shipping regulations or established ion column dose rates. While not commonly recognized, it is possible to exceed 10 nanocuries total plutonium per gram which by regulation would require retrievable storage at the burial site.

41105 (IAEA-CN—36/33) **Criticality control and long term storage of spent fuel.** Toffer, H. (International Atomic Energy Agency, Vienna (Austria)). 1977. 11p. (CONF-770505—234). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

4.3.-.T.1./05.

Development of adequate facilities for long term storage of spent nuclear fuels is a current concern in the nuclear industry. Lack of chemical reprocessing is forcing reactor operators to increase the capacity of their existing pools by structural modifications or by costly investments in new facilities. One of the main constraints governing the utilization of space in a storage pool is nuclear criticality control. The degree of subcriticality of stored fuel is dependent on the fissile material inventory, the arrangement of fuel, and the presence of materials providing parasitic capture of neutrons. Long term storage of spent fuel requires that nuclear criticality considerations include time dependent variations in: fissile isotopic inventory, dispersion of fissile materials, transmutation of fission products, and the deterioration of special neutron control materials. According to current practices in power reactor pools, subcritical units of fuel are stored in a lattice arrangement with sufficient neutronic decoupling between individual fuel bundles. Such decoupling is achieved by adequate isolation in water or by the insertion of special neutron absorbing materials such as Boral. Pool capacity increases by a factor of two have been realized using Boral inserts. An assumption is made in criticality safety analyses that spent fuel has a fissile isotopic composition of unirradiated fuel. The fact that a large fraction of the fissile isotopes have been converted to fission products is not considered. Criticality control calculations and experiments with spent fuel indicate that use of green fuel isotopic compositions introduce safety margins in fuel storage basins which would be equivalent to the neutron control provided by materials such as Boral inserts. Therefore, the use of spent fuel critical mass parameters can serve as an alternate, or as a supplement to special poison inserts for achieving maximum utilization of basin capacity for long term storage of fuel.

41106 (IAEA-CN—36/69) **Experience of European irradiated fuel transport - the first four hundred tonnes.** Curtis, H.W. (International Atomic Energy Agency, Vienna (Austria)). 1977. 7p. (CONF-770505—127). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.3.-.T.1./07 3 tables.

The paper describes the successful integration of the experience of its three shareholders into an international company providing an irradiated fuel transport service throughout Europe. The experience of transporting more than 400 tonnes of irradiated uranium from fifteen power reactors is used to illustrate the flexibility which the transport organisation requires when the access and handling facilities are different at almost every reactor. Variations in fuel cross sections and lengths of fuel elements used in first generation reactors created the need for first generation flasks with sufficient variants to accommodate all reactor fuels but the trend now is towards standardisation of flasks to perhaps two basic types. Increases in fuel rating have raised the flask shielding and heat dissipation requirements and have influenced the design of later flasks. More stringent criticality acceptance criteria have tended to reduce the flask capacity below the maximum number of elements which could physically be contained. Reprocessing plant acceptance criteria initiated because of the presence of substantial quantities of loose crud released in the flask and the need to transport substantial numbers of failed elements have also reduced the flask capacity. Different modes of transport have been developed to cater for the various limitations on access to reactor sites arising from geographical and routing considerations. The safety record of irradiated fuel transport is examined with explanation of the means whereby this has been achieved. The problems of programming the movement of a pool of flasks for fifteen reactors in eight countries are discussed together with the steps taken to ensure that the service operates fairly to give priority to those reactors with the greatest problems. The transport of European irradiated fuel can be presented as an example of international collaboration which works.

41107 (IAEA-CN—36/70) **Some UK experience and practice in the packaging and transport of irradiated fuel.** Edney, C.J.; Rutter, R.L. (International Atomic Energy Agency, Vienna (Austria)). 1977. 7p. (CONF-770505—128). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.3.-.T.1./05 2 figs.

The origin and growth of irradiated fuel transport within and to the U.K. is described and the role of the organisations presently carrying out transport operations is explained. An explanation of the relevant U.K. regulations and laws affecting irradiated fuel transport and the role of the controlling body, the Department of the Environment is given. An explanation is given of the technical requirements for the transport of irradiated Magnox fuel and of the type of flask used, and the transport arrangements, both within the U.K. and to the U.K., from overseas is discussed. The technical requirements for the transport of C.A.G.R. fuel are outlined and the flask and transport arrangements are discussed. The transport requirements of oxide fuel from water reactors is outlined and the flask and shipping arrangements under which this fuel is brought to the U.K. from overseas is explained. The shipping arrangements are explained with particular reference to current international and national requirements. The requirements of the transport of M.T.R. fuel are discussed and the flask type explained. The expected future expansion of the transport of irradiated fuel within and to the U.K. is outlined and the proposed operating methods are briefly discussed. A summary is given of the U.K. experience and the lessons to be drawn from that experience.

41108 (IAEA-CN—36/316) **Spent fuel transportation problems.** Kondrat'ev, A.N.; Kosarev, Yu.A.; Yulikov, E.A. (International Atomic Energy Agency, Vienna (Austria)). 1977. 8p. (In Russian). (CONF-770505—129). U02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.3.-.T.1./02 4 tables, 4 figs.

In this paper, problems of transportation of nuclear spent fuel to reprocessing plants are discussed. The solutions proposed are directed toward the achievement of the transportation as economic and safe as possible. The increase of the nuclear power plants number in the USSR and the great distances between these plants and the reprocessing plants involve an intensification of the spent fuel transportation. Higher burnup and holdup time reduction cause the necessity of more bulky casks. In this connection, the economic problems become still more important. One of the ways of the problem solution is the development of rational and cheap cask designs. Also, the enforcement in the world of the environmental and personnel health protection requires to increase the transportation reliability and safety. The paper summarizes safe transportation rules with clarifying the following questions: the increase of the transport unit quantity of the spent fuel; rational shipment organization that minimizes vehicle turnover cycle duration; development of the reliable calculation methods to determine strength, thermal conditions and nuclear safety of transport packaging as applied to the vehicles of high capacity; maximum unification of vehicles, calculation methods and documents; and cask testing on models and in pilot scale on specific test rigs to assure that they meet the international safe fuel shipment rules. Besides, some considerations on the choice and use of structural materials for casks are given, and problems of manufacturing such casks from uranium and lead are considered, as well as problems of the development of fireproof shells, control instrumentation, vehicles decontamination, etc. All the problems are considered from the point of view of normal and accidental shipment conditions. Conclusions are presented.

41109 (ICP—1109) **Iodine to control microbiological growth in fuel storage basin water.** Wilding, M.W. (Allied Chemical Corp., Idaho Falls, Idaho (USA). Idaho Chemical Programs - Operations Office). Feb 1977. Contract EY-76-C-07-1540. 19p. Dep. NTIS, PC A02/MF A01.

Spent fuel from nuclear reactors is stored underwater for cooling and shielding prior to reprocessing at the Idaho Chemical Processing Plant (ICPP) located near Idaho Falls, Idaho. Transfer and identification of fuel elements underwater requires that the water be almost totally free of suspended solids and microorganisms. This paper describes laboratory and plant operating experience using iodine with an algaecide to control the microbiological population in the water. The residual effect of iodine as a bacteriacide in water is dependent on the concentration of iodine and the concentration of reducing chemicals in the water, but overall, the effectiveness of iodine regenerated by chlorine is superior to that of chlorine alone. Iodine concentrations above 0.75 ppM inhibit the growth of microorganisms, and unlike chlorine, iodine is relatively noncorrosive to metals. The iodide formed by the reduction of iodine is readily reoxidized to iodine with a small amount of chlorine or other oxidant. The iodine injection equipment is simple and requires little maintenance.

41110 (PB—254786) **Potential releases of cesium from irradiated fuel in a transportation accident. Supplement II to WASH-1238. Environmental survey of transportation of radioactive materials to and from nuclear power plants. Technical report.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Standards Development). Jul 1976. 25p. (NUREG—0069). NTIS $3.50.

See also PB-241065.

The supplement updates WASH-1238, 'Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants,' by presenting the information available at this time on cesium release as a result of a transportation accident. (GRA)

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 41352

41111 (IAEA-CN—36/95) **Fuel cycle of the LWR system in the Federal Republic of Germany.** Spalthoff, F.J.; Messer, K.P. (International Atomic Energy Agency, Vienna (Austria)). 1977. vp. (CONF-770505—145). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

1.C.-.P.1./03 This entry prepared from abstract.

Within the framework of a system analysis conducted to forecast the nuclear output capacity that would presumably be installed by the year 2000 in the Federal Republic of Germany, the demands for uranium, enrichment and reprocessing, the fuel fabrication of elements and transportation capacity are determined. The factors of uncertainty involved in forecasts concerning the demand are discussed (analysis of sensitivity). Furthermore, the study points out to what extent the demand for uranium and fuel cycle services is being covered in the FRG and what aspects related to the coverage not yet secured are important. The situation in the field of reprocessing and ultimate disposal in the FRG, and the role which the electrical utilities are to play are in particular dealt with. After a brief survey of the Federal Republic's plans concerning the reprocessing and ultimate disposal issues, the pending problems related to the technology, organization and financing of this sector of the fuel cycle are analyzed. Moreover, the paper deals with the past and probable future development of fuel cycle costs as well as with their influence on the further development of nuclear energy as a whole. It will be examined whether and to what extent the considerable increase in the costs for uranium, enrichment and reprocessing occurring simultaneously with the rise of capital expense for new nuclear power plants has affected the profitability of nuclear energy as compared with fossil primary energies. Finally, the paper discusses how the security of supply for nuclear power plants with fuel and all necessary services could be improved under economically justifiable conditions, and what measures could be taken in this area by the electric utilities, the fuel cycle industries, and the public authorities.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 41104, 41326

41112 (IAEA-CN—36/15) **Management of high level waste.** Culler, F.L. Jr.; Platt, A.M.; Blomeke, J.O. (International Atomic Energy Agency, Vienna (Austria)). 1977. vp. (CONF-770505—214). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.B.-.P.1./02 This entry prepared from abstract.

One of the central problems in nuclear energy is the disposal of wastes. This problem is international in scope; its solution will require intense international cooperation and exchange of data and test results. By the year 2000, worldwide use of nuclear power is estimated to reach between 2000 and 2500 gigawatts (GWe) of electrical generating capacity in countries excluding the USSR and China. Nuclear power stations and supporting fuel cycle facilities will exist on each continent. Safe and internationally accepted methods for the management and isolation of fission products and actinide wastes from these facilities must be developed and demonstrated. Many sites, and hopefully several different geologic formations, will have to be tested and approved for storage of these wastes until they decay to safe levels. This paper estimates the quantity of the various radioactive wastes that will be produced worldwide. The methods for treatment, concentration, fixation, and final storable forms are presented, with particular attention to both the recycle and the disposal of actinides. The transportation of wastes across international boundaries will be required. Estimates of the magnitude of and the complexity of waste movement from points of generation to long-term isolation centers, and the current state of technology available, are given. Ultimately, each type of waste will require a long-term, safe, and publicly accepted repository. This paper concludes with a review of the current programs proposed for ultimate waste isolation, with particular emphasis on storage in geologic formations.

41113 (IAEA-CN—36/28) **Assessment methodology of environmental risks associated with radioactive waste management.** Goldberg, S.M.; Logan, S.E.; Brebano, M.C. (International Atomic Energy Agency, Vienna (Austria)). 1977. 8p. (CONF-770505—227). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.1.-.T.1./05 3 figs.

The U.S. Environmental Protection Agency (EPA) in collaboration with the University of New Mexico has been developing a detailed assessment methodology of both the short-term as well as long-term quantitative risks on the environment resulting from the release of radionuclides during all phases of radioactive waste management operations. This past year a comprehensive model has been developed for the public health and environmental impacts from the disposal of high-level and transuranic waste in geological formations. Parametric studies have been performed with this model for various geological disposal media and for waste in different forms. This comprehensive model has consisted of a release or fault tree model, an environmental model, and an economic model. Fault trees have been constructed to provide the relationships between various geophysical, meteorological, and man-caused events which are potential mechanisms for release of radioactive material to the environment from waste repositories. The environmental model includes the transport to and accumulations at various receptors in the biosphere, including a determination of pathways from environmental input concentrations to radiation dose to man. Finally, the economic results are used to compare and assess the various disposal concepts as a basis for formulating policy decisions. Implementation of this assessment methodology is possible for a whole range of both radioactive as well as non-radioactive hazardous materials which require perpetual care. Further, the output will be used by EPA in the short-term to develop general environmental standards applicable to any radioactive waste management alternative.

41114 (IAEA-CN—36/98) **Waste management in the Federal Republic of Germany: a survey of policy and research and development.** Randl, R.P. (International Atomic Energy Agency, Vienna (Austria)). 1977. vp. (CONF-770505—210). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.B.-.P.1./04 This entry prepared from abstract.

The concept of closing the nuclear fuel cycle in the Federal Republic of Germany is described with special emphasis on waste conditioning and disposal in selected salt formations. The practice and technology of the present status of the treatment of low level wastes and medium level wastes are discussed. The new concept of "in-situ"-solidification of these waste types is given. The r+d-development in this area shows very promising results. The different high level waste-solidification programmes are presented, which are presently carried out in the Federal Republic. It is shown that a broad variety of feasible and safe processes are in hand to secure the appropriate product quality for the terminal storage. The experience on the disposal of low level wastes and medium level wastes is given from the ASSE experimental programme. A large programme on disposal of high level waste has started recently and the future development lines are discussed. The concept for waste management and disposal on the industrial scale e.g. for the "integrated back end fuel cycle park", is presented and the necessary steps to reach the implementation of this concept until the start up operation of the industrial reprocessing plant are described.

41115 (IAEA-CN—36/156) **Development of radioactive waste management at Japan Atomic Energy Research Institute.** Miyanaga, I.; Sakata, S.; Ito, A.; Amano, H. (International Atomic Energy Agency, Vienna (Austria)). 1977. 8p. (CONF-770505—218). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.2.-.T.1./08 2 tables, 1 fig.

For low- and medium-level waste treatment, main efforts have been put on the reduction of waste volume. For high-level wastes, studies are being carried out on the solidification and partitioning techniques in preparation for completion of the fuel cycle in Japan. For sea disposal of low-level wastes planned by the JAEC, significant information has been obtained regarding integrity and leaching behavior of cement solidified wastes. This paper describes the present status of development of the techniques in the following sections; 1. Treatment of Low- and Medium-Level Wastes; an incinerator with two stage ceramic filters has been tested, and the decontamination factor was found to be 10^4 for various nuclides; reverse osmosis method with a cellulose acetate membrane has been tested for laundry liquid waste, and ^{60}Co was removed more than 99% together with detergents; and solidification products of spent ion-exchange resin with polyethylene have been proved to be superior in mechanical properties, water resistance and volume reduction to asphalt products. 2. Safety Evaluation of Cement Solidified Wastes for Sea Disposal; homogeneous cement-solidified wastes in 200 l sealed drums did not show any cracks or defects under high hydrostatic pressure; the leaching ratio of ^{137}Cs for the first one year was estimated to be lower than 0.3%. 3. Treatment of High-Level Wastes; vitrification using natural zeolite has been developed and properties of the products were proved to be excellent; and a partitioning procedure consisting mainly of solvent extraction and ion-exchange method has been studied; reduction of the amount of alkaline agent by introducing a denitration technique, and reduction of resin volume by adopting a porous type resin were achieved.

41116 (IAEA-CN—36/178) **Management of radioactive wastes from nuclear fuels and power plants in Canada.** Tomlinson, M.; Mayman, S.A.; Tammemagi, H.Y.; Merritt, W.F.; Morrison, J.A.; Irvine, H.S.; Vivian, G.A.; Gale, J.; Sanford, B.; Dyne, P.J. (International Atomic Energy Agency, Vienna (Austria)). 1977. 11p. (CONF-770505—212). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.B.-.P.1./05 2 tables, 3 figs.

The nature of Canadian nuclear fuel and nuclear generating plant radioactive wastes are summarized. The status of the development and construction program is indicated. We plan to select a site in either a hard rock formation or in a suitable salt bed by 1981 so that a repository can be constructed to begin a demonstration phase in 1986. The repository is to be capable of eventual expansion to accomodate all Canadian nuclear wastes to at least 2050 when in full-scale operation. Extensive geotechnical studies have been initiated in order to select a site, and design and test the repository. We have demonstrated incorporation of fission products in solids that in the short term (17 years) dissolve more slowly than plutonium decays. A demonstration of dry storage of fuel in concrete containers is in progress. The quantities of CANDU generating-station wastes and the principles and methods for managing them are summarized. Methods for volume reduction and immobilization by solidification are well advanced. A radioactive-waste operations site is being developed with several different types of surface storage, each with multiple barriers against leakage. A reactor decommissioning study has been completed. Estimated costs of the various waste management operations are summarized.

41117 (IAEA-CN—36/187) **Radioactive waste management in Belgium.** Dejonghe, P. (International Atomic Energy Agency, Vienna (Austria)). 1977. 15p. (In French). (CONF-770505—215). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.2.-.T.1./05 4 figs.

In 1975 the research association BELGOWASTE was founded in order to prepare a technical and administrative plan for radioactive waste management in Belgium and to take the prelimi-

nary steps for establishing an organization which would be responsible for this activity. The association made a survey of all forecasts concerning radioactive waste production by power reactors and the fuel cycle industry based on various schemes of development of the nuclear industry. From the technical point of view, the reference plan for waste management envisages: Purification at the production site of large volumes of low-level effluents; construction of a central facility for the treatment and intermediate storage of process concentrates (slurries, resins, etc.) and medium-level waste; centralization assumes the making of adequate arrangements for transporting waste before final treatment; maximum recovery of plutonium from waste and treatment of resiudal material by incineration at very high temperatures; treatment at the production site of high-level effluents from irradiated fuel reprocessing; construction of an underground long-term storage site for high-level treated waste and plutonium fuel fabrication waste; deep clay formations are at present preferred; disposal of low-level treated waste into the Atlantic ocean. It is intended to entrust the entire responsibility for treatment, disposal and storage of treated waste to a single body with participation by the State, the Nuclear Energy Research Centre (CEN/SCK), the electricity companies and Belgonucleaire. The partners intend to set up their facilities and services in the area of Mol.

41118 (IAEA-CN—36/206) **Spanish program on disposal of radioactive wastes.** Lopez Perez, B.; Ramos Salvador, L.; Martines Martinez, A. (International Atomic Energy Agency, Vienna (Austria)). 1977. 9p. (In Spanish). (CONF-770505—230). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.2.-.T.1./06.

The Spanish Energetic Program assumes an installed nuclear electrical power of 23.000 MWe by the year 1985. Therefore, Spain is making an effort in the managment of radioactive wastes, that can be synthesized in the following points: 1.- Make-up and review of the regulation on the management of radioactive wastes. 2.- Development of the processes and equipment for the treatment of solid, liquid and gaseous wastes from the CNEN "Juan Vigon", as well as those from the Nuclear Center of Soria. Solidification studies of RAA wastes arisen from the reprocessing. 3.- Evaluation of radioactive waste treatment systems of the new installed nuclear power plants. Assistance to the nuclear and radioactive facilities operators. 4.- Increase the storage capacity of the pilot repository for solid radioactive wastes of categories 1 and 2 IAEA, located in Sierra Albarrana. Studies of adequate geological formation for storage of solid wastes of IAEA categories 3 and 4. 5.- Studies about long term surface storage systems for solidified RAA wastes arisen from the reprocessing.

41119 (IAEA-CN—36/226) **Management of high level radioactive waste.** Redon, A.; Mamelle, J.; Chambon, M.; Giraud, M.B. (International Atomic Energy Agency, Vienna (Austria)). 1977. 12p. (In French). (CONF-770505—211). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.B.-.P.1./03 1 table.

The world wide needs in reprocessing will reach the value of 10.000 t/y of irradiated fuels, in the mid of the 80's. Several countries will have planned, in their nuclear programme, the construction of reprocessing plants with a 1500 t/y capacity, corresponding to 50.000 MWe installed. At such a level, the solidification of the radioactive waste will become imperative. For this reason, all efforts, in France, have been directed towards the realization of industrial plants able of solidifying the fission products as a glassy material. The advantages of this decision, and the reasons for it are presented. The continuing development work, and the conditions and methods of storing the high-level wastes prior to solidification, and of the interim storage (for thermal decay) and the ultimate disposal after solidification are described.

41120 (IAEA-CN—36/231) **Safety and radiation protection aspects of the management of radioactive wastes of high level activity.** Candes, P.; Pradel, J. (International Atomic Energy Agency, Vienna (Austria)). 1977. 9p. (In French). (CONF-770505—223). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

4.3.-.T.1./07 2 graphs.

Appropriate consideration is given in France to safety and protection problems to be solved from the production up to the final disposal of radioactive wastes of high level activity. The first stage of the work consisted in emphasizing the various technical options. Different strategies app to be possible, taking into account technical, political, and psychological difficulties. This results in evaluating the safety problems to be solved in the framework of those strategies. In this field, the main safety and protection principles do not differ from those which apply to other nuclear facilities. Nevertheless, duration is in most cases a quite different factor (thousands or millions of years). The question is then raised of evaluating the importance to be given to very remote consequences, both at philosophical and scientific levels. As a first result of those considerations, the application of the "barrier" concept is recommended. It is assumed that a limited radioactivity transfer should be taken into account, and its consequences for environment and man be calculated. This is especially true in the study of an appropriate site for final storage, and the study should necessarily include a detailed investigation of the retention characteristics of soil layers, and the implementation of appropriate models giving a sufficiently accurate evaluation of the consequences of transfers, including those related to the effect of various elements after their arrival into the biosphere.

41121 (IAEA-CN—36/282) **Handling of waste at Swedish nuclear power plants.** Mandahl, B.; Persson, B.; Wikdahl, C.E. (International Atomic Energy Agency, Vienna (Austria)). 1977. 7p. (CONF-770505—231). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.2.-.T.2./03 2 tables, 4 figs.

The Swedish nuclear power program started with a 460 MW BWR at Oskarshamn in 1972. The main practical experience in nuclear waste management originates from this unit. Since 1975 five further reactor units have been taken into use and there are now definite plans for a total of 13 units. The waste handling in Sweden now considered is therefore orientated towards a system with 13 operational units. The paper describes the end products and the waste handling systems currently in use. Present day methods and equipment will be discussed as well as trends towards modification of these techniques. Estimates will be made of the quantities of the end products and their radioactive content. Necessary decay times before the waste can be released as nonactive material will also be estimated. Lay-out and capacity of the waste stores at some plants and the need for transport equipment at the sites will be described. The paper also discusses the need for centralized long term storage and even methods for centralized waste treatment aimed at reducing the volume of materials requiring storage.

41122 (IAEA-CN—36/350) **Development of methods for solidification and disposal of fuel cycle radioactive wastes.** Dolgov, V.V.; Kolychev, B.S.; Konstantinovich, A.A.; Kulichenko, V.V.; Nikipelov, B.V.; Nikiforov, A.S.; Martynov, Yu.P.; Oziraner, S.N.; Sedov, V.M.; Shatsillo, V.G. (International Atomic Energy Agency, Vienna (Austria)). 1977. 26p. (In Russian). (CONF-770505—225). Dep. NTIS (US Sales Only), PC A03/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.2.-.T.2./08.

The report deals with methods for disposal of radioactive wastes from reprocessing plants. Apparatuses and flow-sheets developed in the USSR for solidification of low- and intermediate-level wastes are discussed. The main research and developement results on the high-level waste treatment by two methods are presented. The first method comprises production of vitreous materials in an electric furnace without pre-calcination. The second one involves pre-dehydration and calcination of liquid wastes in a fluidized bed facility followed by vitrification in a ceramic crucible. Processes for the intermediate-level wastes solidification are also discussed. The study of behaviour of various solidified wastes (vitreous, bitumenized, etc.) in storage has allowed the disposal conditions to be developed. The paper considers the design of storages located directly at fuel reprocessing plants. The main technical and economic data are given on the solidification and storage processes for solids.

41123 (IAEA-CN—36/388) **Management of radioactive wastes: an overview of the Indian programme.** Thomas, K.T.; Sunder Rajan, N.S.; Balu, K.; Khan, A.A. (International Atomic Energy Agency, Vienna (Austria)). 1977. 7p. (CONF-770505—221). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.2.-.T.1./04 2 figs., 1 table.

An overview of the management of radioactive wastes with particular reference to the Indian Nuclear Programme is presented. The initial design philosophy of the radwaste management system is discussed in relation to accepting a calculated, minimum discharge of radioactivity to the environment. A brief report of the operational experience with the low and intermediate level radwaste systems is given. Factors that influence the review of the present philosophy for future adoption are presented. Some methods being developed for decreasing release of the radioactivity to the environment are discussed. Among techniques considered are solar evaporation, delay and decay of fission rare gases from power reactors and concentration and storage of Kr 85 from fuel reprocessing plants. Problems in the management of high level and alph-bearing wastes are discussed with particular reference to the nature of the waste generated and the policy under implementation for their management. The matrices, solidification processes, modes of interim storage and criteria for selection of site for ultimate dispensation of the

solidified high level wastes in geological formations are described. An approach towards the solution of the probelm of management of alpha-bearing waste is also presented.

41124 (IAEA-CN—36/418) **Management of wastes containing radioactivity from mining and milling of uranium ores in Northern Australia.** Costello, J.M. (International Atomic Energy Agency, Vienna (Austria)). 1977. 8p. (CONF-770505—224). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.2.-.T.2./01 4 figs., 1 table.

The procedures and controls to achieve safe management of wastes containing radioactivity during the mining and processing of uranium ores are mainly site specific depending on the nature, location and distribution of the ore and gangue material. Waste rock and below-ore-grade material containing low levels of radioactivity require disposal at the mine site. In open cut mining the material is generally stockpiled above ground, with revegetation and collection of run-off water. Some material may be used to backfill open cuts. Management of these wastes requires a thorough investigation of ground water hydrology and surface soil characteristics to control dissipation of radioactive material. Dust containing radon and radioactive particulate is produced during ore milling, and dusts of ore concentrate are generated during calcination and packaging of the yellowcake product. These dusts are managed by ventilation and filtration systems, working conditions, and discharges to atmosphere will be according to the Australian Code of Practice on Radiation Protection during Mining and Milling of Uranium Ores. The chemical waste stream from leaching and processing of the uranium ores contains the majority of the radioactivity resulting from radium and its decay products. Neutralised effluent is discharged into holding ponds for settling of solids. This paper describes the nature of wastes containing radioactivity resulting from the mining and milling of uranium, and illustrates modern engineering practices and monitoring procedures to manage the wastes, as described in the Environmental Impact statement produced by Ranger Uranium Mines Proprietary Limited for public hearings.

41125 (IAEA-CN—36/479) **Management and control of radioactive wastes from uranium-milling operations.** Kennedy, R.H.; Deal, L.J.; Haywood, F.F.; Goldsmith, W.A. (International Atomic Energy Agency, Vienna (Austria)). 1977. 8p. (CONF-770505—209). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.2.-.T.2./02 1 table, 3 figs.

Of the 39 privately owned mills that produced and sold uranium to the U.S. Government during 1948 to 1971, 22 have closed down either due to exhaustion of reserves or lack of market. On the inactive mill sites there remains 24 million metric tons of tailings containing 14,000 curies of radium. Success in stabilization has been variable. In the past, theoretical models have had to be used in estimation of the environmental effects of uranium milling for lack of a sufficient factual base. ERDA in cooperation with the Environmental Protection Agency and the states involved is undertaking a comprehensive radiological assessment at each site. The results of this assessment should provide valuable basic information on the environmental impact of uranium ore processing. The current studies reveal that the inactive sites are a cause of small public exposure to radiation, primarily from radon-222 from the tailings piles. This paper reviews radioactivity management in uranium ore processing to control spread of radioactive materials, including methods used for stabilization to prevent wind and water erosion. Recent measurements of radioactivity levels in soils, ground and surface waters, and in air near tailings piles are summarized, and public health implications are evaluated. Guidelines have been developed for land decontamination, and procedures evaluated for long-term management of contaminated material to minimize future human exposure. Alternative methods for long-term tailings stabilization, their costs and benefits in terms of serious health effects avoided are presented.

41126 (IAEA-CN—36/491) **Present trends in radioactive waste management policies in OECD countries and related international cooperative efforts.** Olivier, J.P. (International Atomic Energy Agency, Vienna (Austria)). 1977. 13p. (In French). (CONF-770505—220). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.B.-.P.1./01.

In recent years waste management has received increased attention not only at the national level but also internationally in order to harmonise to some extent the policies and practices to be followed and to continue to achieve a high safety standard in this field. In particular, discussions are taking place between OECD Member countries on the definition of objectives, concepts and strategies for radioactive waste management with a view to presenting coherent overall systems covering not only the treatment and storage aspects for the short term but also the longer term problems of disposal in the context of a rapidly developing nuclear fuel cycle. The technical, administrative, legal and financial aspects of the waste management problems are being discussed and various approaches are envisaged for the future. In addition to the discussion of policies and practices, a significant effort is also being initiated on research and development. The disposal problem has been given priority particularly as far as high level waste and alpha bearing wastes are concerned. Close international co-operation has been initiated in this sector as well as on the conditioning of high level radioactive waste. As a result of these efforts an international R and D programme is being established at the site of the Eurochemic reprocessing plant on the incorporation of high level waste into metal matrices. Increased co-operation is also taking place concerning other waste management problems such as the management of gaseous waste, alpha waste and cladding hulls and the question of dismantling and decommissioning of obsolete nuclear facilities. The paper describes in detail the results achieved so far through this co-operation between OECD Member countries and presents current plans for future activities.

41127 (IAEA-CN—36/511) **Goals, objectives and criteria for the management of nuclear wastes: rethinking the problem.** Bishop, W.P.; Frazier, D.H. (International Atomic Energy Agency, Vienna (Austria)). 1977. 17p. (CONF-770505—207). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.2.-.T.1./02 1 fig., 2 tables.

The question of the management of nuclear wastes in a perpetually safe manner transcends the usual bounds of technology and encompasses social, political and even ethical issues. The interweaving of the technical, social, political and ethical facets of the issue is explored in this paper. The system for the management of the wastes (the technology plus institutions and organizations required) is not self-implementing. Action is required, and the time for that action is now. Guiding principles are outlined in the paper. They fall into three important time frames: 1) the period of active use of fission nuclear power; 2) the period of active societal involvement in waste management (which may extend beyond the life of the industry); and 3) the entire period over which the waste management system must operate (which can extend beyond the time of active societal involvement). The goals call for action now with full treatment of all the relevant issues in the decision process. In stating the goals, two questions arise in logical sequence: 1) How do we use the goals in designing and implementing a waste management system. and 2) How far must we go in the directions indicated. The remainder of this paper describes the program for the providing of those criteria in a logical order and in a very few years.

41128 (IAEA-CN—36/554) **Management of radioactive waste and plutonium in the Swedish perspective.** Larsson, A.; Hultgren, A.; Lind, J. (International Atomic Energy Agency, Vienna (Austria)). 1977. 6p. (CONF-770505—216). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.2.-.T.1./07.

In May 1976 the Governmental Committee on Radioactive Waste (the Aka Committee) submitted its final report to the Swedish Government. The report summarizes a thorough investigation of questions dealing with spent nuclear fuel and radioactive waste. For Sweden, the study recommends reprocessing of spent fuel as a primary alternative. Basically national reprocessing, including possibilities for international, particularly Nordic, regional collaboration is envisaged by the Committee. The findings and proposals of the Committee are discussed in the light of the recent development on the nuclear scene in Sweden. As to the economic side, it is argued that the utilities should include all costs relating to the back end in the budgets for their energy production programmes. Reprocessing and waste management neither can nor should be seen as ordinary commercial ventures. Consequently the planning to cover the important needs at the back end of the nuclear fuel cycle is hardly likely to be initiated and undertaken by means of the market mechanism.

41129 **Radioactive waste management: model analysis of a proposed site.** Schwartz, F.W. (Alberta Univ., Edmonton (Canada). Dept. of Geology). *J. Hydrol.;* **32**: No. 3, . 257-277(Feb 1977).

The proposed waste-management site at the Defence Research Establishment Suffield appears suitable for storing solid low-level radioactive wastes with a half-life for radioactive decay less than 3,000 years. This conlusion is based on model trials which generally indicate that the subsurface environment will be effective in limiting the dispersal of radioactive contaminants in the groundwater system. Contaminant attenuation is produced by the physical process of dispersion, the chemical process of cation exchange and the nuclear process of radioactive decay. A strong measure of contaminant confinement is provided by the relatively low seepage velocity within the porous medium. Parameters in the model are derived from empirical relationships and a variety of field and laboratory studies conducted over the past two years. Piezometric

data indicate that the site is predominantly a recharge area with the permeability of geologic units ranging from 1.10^{-5} to 2.10^{-8}cm s^{-1}. Measured values of cation-exchange capacity for drift and bedrock units range from 25 to 105 mequiv./100 g. An unsaturated zone up to 36 m thick, a lack of water-level fluctuations, and a semi-arid climate are evidence of the limited quantities of natural recharge to the groundwater system. Soil-moisture data demonstrate the most favourable sites for recharge are depressions within the area.

WASTE PROCESSING

REFER ALSO TO CITATION(S) 41323, 41325, 41348, 41460

41130 (COO—2510-12) **Advanced waste forms research and development. Comprehensive progress report.** McCarthy, G.J. (Pennsylvania State Univ., University Park (USA). Materials Research Labs.). 22 Mar 1977. Contract EY-76-S-02-2510. 46p. Dep. NTIS, PC A03/MF A01.

Progress is reported in the following research areas: cesium fixation in aluminosilicates and supercalcine development; low sodium wastes and high sodium wastes. Phase relations in the appropriate (for supercalcine) portion of the Cs_2O-Al_2O_3-SiO_2 system are being investigated. Several compatibility lines (tie lines) have been established on the phase diagram. Methods of preparing pure single phases of $CsAlSiO_4$ and $CsAlSi_2O_6$ (pollucite) are being developed. Compatibility studies continue to be the basis of supercalcine crystalline phase formation modeling. (LK)

41131 (IAEA-CN—36/186) **Evaluation of solidification matrices proposed for nuclear power plant radwaste.** Mergan, L.M.; Vandorpe, M.; van de Voorde, N. (International Atomic Energy Agency, Vienna (Austria)). 1977. 15p. (CONF-770505—217). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.2.-.T.2./07.

The question of the solidification and conditioning of the nuclear power plant radwaste has not yet been answered to the full satisfaction of the plant operators. The problem is to accommodate miscellaneous kind of effluents by means of flexible, reliable and easy to maintain facilities which yield a solidified product which can safely be transported and stored in compliance with the regulations. As a contribution to this important subject, the paper presents an evaluation of some commonly proposed solidification processes, namely: incorporation into cement, bitumen or polymers. This assessment is mainly based on an experimental comparison study being carried out by BELGONUCLEAIRE and also on reported results and experience in the field. The evaluation successively examines the following points in relation to the various categories of LWR waste: the influence of an adequate pretreatment on the process and on the final product quality; the problems raised by the separation through vaporization of the water and the dry solids; the properties of the matrix materials; the incorporation technique of the dried solids in the solidification matrix, and some of the solidified product properties, namely; the behaviour under water and the lixiviation, the mechanical characteristics (compression, impact,...), resistance to fire, compatibility and stability, volume reduction, etc... and points out the respective advantages and drawbacks of the various methods. The paper then infers some recommendations, considering the desirable installation features from the operational and the environmental viewpoints.

41132 (IAEA-CN—36/317) **Discharge into the atmosphere of volatile fission products from nuclear power stations and fuel reprocessing plants and the perspectives of their retention.** Galkin, B.Ya.; Gedeonov, L.I.; Demidovich, N.N.; Lyubtsev, R.I.; Petryanov, I.V.; Sadovskii, B.F.; Sokolov, V.N.; Trofimov, A.M. (International Atomic Energy Agency, Vienna (Austria)). 1977. 15p. (In Russian). (CONF-770505—208). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.2.-.T.2./11 Also available in English.

The paper deals with generation and behaviour of volatile fission products, including those from reprocessing nuclear fuels. Spreading of krypton-85, tritium and iodine-129 in the atmosphere and water is reviewed. Future trends as well as regional and global effects due to progress in nuclear power industry are evaluated. Peculiar distribution of volatile fission products in reprocessing nuclear fuel by extraction and difficulties presented by intricate chemical behaviour of iodine are shown. The paper also deals with some problems of gaseous waste reprocessing technique in view of requirements for environment protection. Gas purification from short-lived isotopes at Soviet atomic power stations with PWR is discussed. The purification system for gaseous effluents from fuel reprocessing facilities is more complicated. Utilization of stable xenon which evolves during dissolution of fuel elements allows to offset partially the expenditure. Some methods for the Kr-85 and Xe recovery are therefore considered. A number of reprocessing procedures gives liquid and solid aerosols. Low-speed self-purificating fine fibrous filters can be used for effective cleaning from liquid aerosols (mists). The mechanism of the filter operation, their performance as a function of the height of a capillar column and operating at the efficiency of greater than or approximately equal to 99,9% are discussed. Recently regenerable metal-cloth filters find use in cleaning from solid aerosols, which make it possible to reuse recovered valuable products. These stainless steel filters are used for high-temperature gases at inlet dust concentrations from milligram to gram quantities in a cubic metre of a gas purified. The filter characteristics and their possible application are discussed.

41133 (IAEA-CN—36/366) **Nuclear transmutation of actinides other than fuel as a radioactive waste management scheme.** Cecille, L.; Hage, W.; Hettinger, H.; Mannone, F.; Mousty, F.; Schmidt, E.; Sola, A.; Huber, B.; Koch, L. (International Atomic Energy Agency, Vienna (Austria)). 1977. 10p. (CONF-770505—213). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.2.-.T.1./12 2 figs.

The bulk of fission products in the high-level waste (HLW) decays to innocuous hazard levels within about 600 years. Actinide waste and a few fission products however represent a potential risk up to some hundreds of thousand of years. An alternative to the disposal of the whole HLW in geological formations is its fractionation, a nuclear transmutation of long-lived isotopes in fission reactors and a geological disposal of the other components. This solution would decrease the potential long-term risks of the geological waste disposal and would also accomodate to the demand of public opinion. The results of studies related to this management scheme are outlined with special reference to areas, where additional effort is required for realistic cost/benefit evaluations. Transmutation rates are sufficiently high to guarantee acceptably small actinide inventories in the reactor in the case of self-generated actinide recycling. It appears that fast breeders could be used as transmutation devices without major additional reactor development work. Calculations permitted the identification of isotopes for which cross section masurements and improved theoretical methods are required. The chemical separation of actinides from the HLW with the envisaged decontamination factors is being studied by solvent extraction and precipitation techniques. The main lines of research and its progress are outlined. Additional risk and cost problems caused by actinide recycling for the fuel cycle and reactor operation are discussed.

41134 (IAEA-CN—36/470) **Correlation of composition, structure characteristics and properties for high level waste solidification products.** Neumann, L.; Vojtech, O.; Santarova, M.; Stejskal, J.; Hulinsky, V. (International Atomic Energy Agency, Vienna (Austria)). 1977. 8p. (CONF-770505—219). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.2.-.T.2./09 2 figs.

The final product of a high level liquid waste solidification process should meet a number of quantitative criteria. The necessary data can be obtained by a direct measurement of certain parameters of the product (leachability of important radionuclides from the basic matrix, total solubility of the final product, thermal conductivity, mechanical properties, the temperature dependence of viscosity etc). Some insight can also be obtained on the basis of a profound analysis of micro- and macrostructure of the solid product. With regard to the complex chemical composition of initial wastes and of the final ceramic or glassy product, and especially to the long-term combined effect of the intense radiation and elevated temperature, it is rather difficult to correlate the desired properties of the product and their supposed development during the long-term storage with the initial conditions and process characteristics. In this point, the detailed knowledge of the structure improves the possibility to evaluate the final product and enables to influence reversely the process itself. In this paper an effort is made to find a relationship "System composition - system structure - product properties" resulting from specific process conditions. The study is demonstrated on the system of fission products and corrosion products mixture in a phosphate matrix over an extended concentration scale. For the analysis of the structure properties x-ray diffraction, microscopic and electron probe micro-analysis (back-scattered electrons and characteristic x-radiation detection) have been used. Using standard methods, the hydrolytical resistance of the product and the selective leachability of caesium, strontium and rare earth ions have been measured. The results obtained so far, confirmed the usefulness of structure analysis as a parallel method for the product evaluation in the process development and probably also for the large-scale application.

WASTE DISPOSAL AND STORAGE

REFER ALSO TO CITATION(S) 41868

41135 (COO—2689-6) **Seabed disposal program: geochemical and sedimentological studies of North Pacific sediments. Progress report, January 1, 1976—December 31, 1976.** Heath, G.R.; Epstein, G.; Prince, R.A. (Rhode Island Univ., Kingston (USA). Graduate School of Oceanography). Mar 1977. Contract EY-76-S-02-2689. 60p. Dep. NTIS, PC A04/MF A01.

Sorption experiments involving deep-sea (MPG) clays from the North Pacific and Th (as a "model" heavy metal) in 0.7M NaCl solutions have shown that the Th partition coefficients (K/sub p/) between clay and solution can be described by a relation of the form Log kp = -A log C + BT + Q where A (approximately 0.8), B (0.003 to 0.008) and Q (-0.8 to 0.3) are constants for each clay, Kp is in ml/g, C, the dissolved Th concentration, is in moles, and T is in °C. This equation is valid for temperatures of 5 to 85°C and Th concentrations of 10^{-2} to 10^{-9}M. K/sub p/ values are in the 10^4 to 10^6 ml/g range for Th concentrations in the micromolar range, lending support to earlier laboratory and field studies which suggest that K/sub D/ values for dilute solutions of transition metals, lanthanides, and actinides in seawater relative to deep-sea sediments generally lie in the 10^4 to 10^5 range. DRM studies of MPG-I sediments show that accumulation rates grade from less than 0.5 m/my prior to 4 million years ago, to as much as 2 m/my today. NRM studies of several MPG-I piston cores suggest that, as in MPG-II, rates of sedimentation can vary by a factor of 1.8 within the region, but that the relative fractionation from site to site has not changed over several tens of millions of years, leading to a high degree of confidence in the predictability of the geologic future of the region.

41136 (IAEA-CN—36/67) **Options for the disposal of high-level radioactive waste.** Mitchell, N.T.; Gray, D.A.; Hookway, B.R.; Laughton, A.S.; Stott, G.; Webb, G.A.M. (International Atomic Energy Agency, Vienna (Austria)). 1977. 8p. (CONF-770505—232). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.2.-.T.1./10.

The management of radioactive waste within the fuel cycle, especially the high-level wastes from reprocessing of nuclear fuel, is currently a matter of particular concern. In the short term (meaning a timescale of tens of years) management by engineered storage is considered to provide a satisfactory solution. Beyond this, however, the two main alternative options which are considered in the paper are: (a) disposal by burial into geologic formations on land; and (b) disposal by emplacement into or onto the seabed. Status of our present knowledge on the land and seabed disposal options is reviewed together with an assessment of the extent to which their reliability and safety can be judged on presently available information. Further information is needed on the environmental behaviour of radioactivity in the form of solidified waste in both situations in order to provide a more complete, scientific assessment. Work done so far has clarified the areas where further research is most needed - for instance modelling of the environmental transfer processes associated with the seabed option. This is discussed together with an indication of the research programmes which are now being pursued.

41137 (IAEA-CN—36/289) **Review of Dutch geologic waste disposal programme.** Hamstra, J.; Verkerk, B. (International Atomic Energy Agency, Vienna (Austria)). 1977. 6p. (CONF-770505—228). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.2.-.T.1./11 3 tables, 4 figs.

In 1972 work started to explore possibilities in the Netherlands for permanent disposal of radioactive wastes in one of the Zechstein salt formation present in the North-eastern part of the country. It was decided to aim at a leached-out cavity for disposal of low and medium level solid wastes, mainly arising at power stations and at a mine as a repository for solidified reprocessing waste. The latter would be needed only at a later date than the cavity, but both had to be located in the same formation. Site selection work, in close cooperation with the State Geologic Service and using information kindly provided by the oil and salt companies, led to the choice of 5 preference formations. Preparatory work was done to perform three reconnaissance drillings in the first choice salt dome. Design of the cavity and infrastructure is described as well as the deep bore hole concept developed in order to make optimal use of the full salt dome geometry. One of the drillings will be extended to a depth of 2600 m and in the bore hole convergence measurements will be made to show the feasibility of the vertical storage concept. A review is also presented of the safety analysis performed, and of the programme for the coming years, foreseen to be carried out under contract with the Commission of the European Communities. Closely related to the safety aspect are soil retention measurements that have been performed with fission product and actinide nuclides in nearly saturated salt solutions in order to evaluate retention times after a postulated water leaching incident.

41138 (IAEA-CN—36/313) **Radioactive waste disposal in geological formations.** Gera, F. (International Atomic Energy Agency, Vienna (Austria)). 1977. 12p. (In French). (CONF-770505—226). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.1.-.T.1./08.

Consideration of the evolution of the hazard potential of waste in function of decay time leads to a somewhat conservative reference containment time in the order of one hundred thousand years. Several concepts have been proposed for the disposal of long-lived wastes. At the present time, emplacement into suitable geological formations under land areas can be considered the most promising disposal option. It is practically impossible to define detailed criteria to be followed in selecting suitable sites for disposal of long-lived wastes. Basically there is a single criterion, namely; that the geological environment must be able to contain the wastes for at least a hundred thousand years. However, due to the extreme variability of geological settings, it is conceivable that this basic capability could be provided by a great variety of different conditions. The predominant natural mechanism by which waste radionuclides could be moved from a sealed repository in a deep geological formation into the biosphere is leaching and transfer by ground water. Hence the greatest challenge is to give a satisfactory demonstration that isolation from ground water will persist over the required containment time. Rock salt and argillaceous sediments are considered the most favorable media since they behave plastically and large masses of these materials should be capable of withstanding significant diastrophism without acquiring secondary permeability. However it is possible that in areas of great tectonic stability and in particularly favorable geological situations other materials, less intrinsically advantageous, might also be acceptable.

41139 (IAEA-CN—36/345) **Scientific prerequisites and practice for using deep water-bearing horizons for disposal of liquid radioactive wastes.** Spitsyn, V.I.; Pimenov, M.K.; Balukova, V.D.; Leontichuk, A.S.; Kokorin, I.N.; Yudin, F.P; Rakov, N.A. (International Atomic Energy Agency, Vienna (Austria)). 1977. 19p. (In Russian). (CONF-770505—233). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.2.-.T.1./09 5 figs.

One of the most promising methods of safe disposal of liquid radioactive wastes in the U.S.S.R. is the creation of storages in deep water-bearing horizons, in zones of stagnant regime or slow water exchange of underground waters. The results of investigations and practice of disposal testify to the safety and efficiency of such a method of final disposal of the wastes when the main requirements for protecting the environment are being fulfilled. The main requirements and criteria are formulated which must be met by geological structures and stratum-collectors to ensure safe disposal of wastes. Positive and negative factors characterizing the method are analyzed. There is an appreciation of possible wrecking situations at underground disposal. The composition and methods of geological surveying, hydrodynamic, geophysic, physico-chemical and health safety investigations are considered in brief, as well as the methods of calculations and prediction of movement of wastes in the earth's crust, way of waste preparation for disposal and chemical methods of restoration of response of the wells, constructive features and conditions for putting the wells into operation, methods of evaluation of heating and the processes of radiolysis for the medium containing the wastes of high-level radioactivity, ways of effective remote control of disposal and environments, etc.

41140 (IAEA-CN—36/346) **Evaluation of the limits of radioactive waste disposal into water systems of international importance.** Blinov, V.A.; Gedeonov, L.I.; Gustova, L.I.; Ivanova, I.M.; Lazarev, L.N.; Rakov, N.A. (International Atomic Energy Agency, Vienna (Austria)). 1977. vp. (In Russian). (CONF-770505—222). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.1.-.T.1./04 This entry prepared from Russian.

The IAEA criteria for determination of the concept of high level radioactive waste, which is forbidden to be disposed into seas and oceans according to the London Convention 1972 are considered. It is proposed to revise this concept every five years using the experience, which may be acquired due to the present disposal practice in the Atlantic. The data on the assessment of global fallout quantities introduced into the Atlantic and on the dilution of contamination in its waters are given. A problem is discussed on the principles of international collaboration in accepting limiting rates of disposal into water systems of international importance. It is shown that in the Irish Sea and in the North Sea sources of radioactive contamination have arisen, which would be dangerous for the Baltic. Cooperative research of the Baltic within the ECC frames is reported. A review and evaluation of radiation conditions and their trends in the Baltic Sea is given. The problem of mutual cooperation in limiting the Danube radioactive pollution between countries in the Danube Catchment Area is discussed. A review and a forecast of trends of radiation conditions in the Danube Area are given.

41141 (PB—258259) **Review of state licenses for disposal of low-level radioactive waste by shallow land burial. Technical note.** Mann, B.J.; Nelson, D.J. (Environmental Protection Agency, Las Vegas, Nev. (USA). Office of Radiation Programs). Jun 1976. 39p. (ORP/LV—76-3). NTIS $4.00.

State licenses for disposal of low-level radioactive wastes at commercial burial sites are reviewed. Information concerning license terms and conditions, and license administration has been obtained from questionnaires sent to those six states with commercial radioactive waste burial sites. The questionnaire information has been supplemented by recent reports of the Task Force on Radioactive Waste Management of the Conference of Radiation Control Program Directors and personal communications with knowledgeable officials in state and Federal agencies. A number of problems associated with licensing and license administration by the states have been identified by the Task Force, by the Federal Government Accounting Office (GAO), and by various state and Federal officials. These are summarized and recommendations are included. (GRA)

41142 (Y/OWI/SUB—76/16503) **Storage fee analysis for a nuclear waste terminal storage facility. Final report.** (Science Applications, Inc., Oak Ridge, Tenn. (USA)). Sep 1976. Contract W-7405-ENG-26;SUB-86Y-16503V. 61p. Dep. NTIS, PC A04/MF A01.

A model was developed for determining a pricing schedule designed to recover federal government costs incurred in the development, design, construction, operation, decommissioning, and surveillance of a federal repository for high-level waste generated by the commercial nuclear power industry. As currently constructed, the model computes current dollar prices on a yearly basis for a single unit charge or a split fee based upon two user-provided quantity flows. Over the period of facility operation, the computed-cost schedule shows variability on a year-to-year basis only within specified ranges. The model uses as basic input data: cost schedule for the federal repository; quantity flow schedule for each factor to be charged; schedule for escalation rate, discount rate, and interest rate; and fraction of costs to be recovered on each quantity flow if the split-fee option is used. The model allows testing of these variables in order to determine the relative significance of each component with regard to cost to, and impact on, the nuclear power industry. Another feature of the model is its versatility. Not only is the user able to specify the percent of total costs to be covered by each method of fee assessment listed above but also the user can specify a revenue-cost ratio, an option that would prove useful in trying to assess the general uncertainty involved when dealing in the future. In addition, the model accepts either current-dollar or constant-dollar cost measures, and in the case of the latter escalates the costs with user-provided assumptions.

41143 (Y/OWI/TM—22) **Statement of C.D. Zerby before the California Energy Resources Conservation and Development Commission, Sacramento, California, March 21, 1977.** Zerby, C.D. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Office of Waste Isolation). 1977. Contract W-7405-ENG-26. 38p. Dep. NTIS, PC A03/MF A01.

The text of C. D. Zerby's presentation before the California Energy Resources Conservation and Development Commission on disposal of radioactive wastes in salt deposits is given. Some of the topics discussed are; development sequence for a terminal storage facility; description of a repository in salt; geological properties of salt formations important for waste disposal; and performance characteristics of waste repository. (LK)

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 41113, 41140

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 42093, 42094, 42095, 42096, 42097, 42098, 42099, 42100, 42101, 42102, 42103, 42104, 42105, 42106, 42107, 42108, 42109, 42110, 42111, 42112, 42113, 42114

41144 (JAERI-M—6486) **Manual on safety handling of UF_6.** (Japan Atomic Energy Research Inst., Tokyo). Mar 1976. 20p. (In Japanese). Dep. NTIS (US Sales Only), PC A02/MF A01.

Instructions on safety handling of UF_6 are given including physical, chemical and nuclear properties, flammability, corrosiveness, toxity, detection method, cautions in transport and storage, waste treatment, fire hazard, hygiene and first-aid.

REGULATIONS

ACCOUNTABILITY AND SAFEGUARDS

41145 (ORNL/CSD/TM—25) **New approach to safeguards accounting.** Pike, D.H.; Morrison, G.W. (Oak Ridge National Lab., Tenn. (USA)). Mar 1977. Contract W-7405-ENG-26;NRC-INA-40-549-75. 60p. Dep. NTIS, PC A03/MF A01.

In recent years there has been widespread concern over the problem of nuclear safeguards. Due to the proliferation of nuclear reactors throughout the world, the concern about the loss or diversion of nuclear materials at various points in the fuel cycle has greatly increased. To minimize the possibility of material loss, the nuclear industry relies on physical protection systems and materials accountability procedures at licensed facilities. Present techniques of material accountability rely on double-entry accounting systems. For various reasons, only noisy observations of on-hand inventory are available. Hence one is forced to use statistical techniques in an attempt to detect the existence of missing material. Current practice is to use control charts as the basis for detecting significant material losses. Control charts may aid in detecting large material losses but are insensitive to small quantities of material loss, even if these small losses occur repeatedly over a long period of time. The purpose of this research is to show the feasibility of using linear state estimation theory in nuclear material accountability. The Kalman Filter is used as the state estimation technique. The state vector which consists of on-hand inventory and material losses is estimated recursively.

41146 **Overall probability of detection in connection with the optimization of safeguards effort.** Hartmann, G. (Kernforschungszentrum, Karlsruhe, Ger.). *Nucl. Technol.;* **32**: No. 3, 290-296(Mar 1977).

A model for inspection, and its application to a reprocessing plant of the Nuclear Fuel Services type, have been developed. Two possible means of diverting material are (a) diverting material within the uncertainty of the material balance and (b) falsifying data. Statistical tests are performed by the inspecting authority: In the first case, the inspector compares material unaccounted for (MUF) with a significance threshold, while in the second case, a sample of the reported data is compared with his own remeasurements. Both methods are combined, and the optimal control and diversion strategies are computed (for an assumed probability of a false alarm and the amount to be diverted).

FUSION FUELS

PROCESSING

41147 (LA—6583) **Electroless or autocatalytic coating of microparticles for laser fusion targets.** Mayer, A.; Catlett, D.S. (Los Alamos Scientific Lab., N.Mex. (USA)). Apr 1977. Contract W-7405-ENG-36. 4p. Dep. NTIS, PC A02/MF A01.

Use of a novel device for applying uniform metallic coatings to spherical microparticles is described. The apparatus deposits electroless metal coatings on hollow, thin-walled metal or sensitized nonmetallic micromandrels. The apparatus and process were developed for fabrication of microsphere pressure vessels for use as targets in laser-initiated fusion research.

41148 (LA—6584) **Electrolytic coating of microparticles for laser fusion targets.** Mayer, A.; Catlett, D.S. (Los Alamos Scientific Lab., N.Mex. (USA)). Apr 1977. Contract W-7405-ENG-36. 6p. Dep. NTIS, PC A02/MF A01.

An electroplating apparatus for applying uniform metallic coatings that have excellent surface finishes to discrete microparticles is described. The device is used to electrodeposit metals onto thin-walled metal, metallized glass, or plastic mandrels. The apparatus and process were developed for fabrication of microsphere pressure vessels to be used as targets in laser fusion research.

41149 (LA-UR—75-2053) **Recent developments in laser-fusion target coatings.** Fries, R.J.; Catlett, D.S.; Fossey, D.; Mayer, A.; McCreary, W.J.; Powell, B.W.; Simonsic, G.A. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-ENG-36. 17p. Dep. NTIS, PC A02/MF A01.

Techniques to fabricate hollow, spherical, multilayered laser-fusion targets are described. The first is a glow discharge polymerization process for plastic coating. A chemical vapor deposition process for depositing Mo/Re alloys is also discussed along with some new techniques for electrodeless plating and for electroplating a wide variety of metals. (MOW)

41150 **Thermonuclear fuel and preparation process.** (to KMS Fusion, Inc). French Patent 2,293,036/A/. 26 Nov 1974. 21p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

A process is described for the preparation of a thermonuclear fuel having a configuration suitable for a laser triggered fusion process. It includes the selection of a hollow glass microsphere with a diameter between 60 and 500 microns and a wall thickness between 0.6 and 3 microns, the heating of the microspheres to a temperature of around 300 deg C, the application of a gaseous thermonuclear fuel atmosphere to the exterior of the microspheres for about 96 hours, so that the gaseous fuel penetrates inside the microsphere. The microsphere is then cooled to ambient temperature for storage.

41151 Thermonuclear fuel and its preparation process. Henderson, T.M.; Rensel, W.B.; Wuttke, G.H. (to KMS Fusion, Inc). French Patent 2,292,312/E/. 4 Nov 1975. 5p. (In French).

Addition to the French patent document 7438779. Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 20 Nov 1974, US.

The process described is for improving the heat transfer characteristics in thermonuclear fuel pellets. The main feature of this process is the introduction of a gas into the pellets. It includes the selection of a hollow glass microsphere, the introduction of a mixture of a thermonuclear fuel and a gas with better heat transfer characteristics than the thermonuclear fuel into the pellet by high pressure and temperature diffusion, and treatment of the charged pellets at cryogenic temperatures so that the fuel condenses on the inner walls of the pellet and congeals as a solid fuel. The gas mixed with the thermonuclear fusion fuel is helium present at a pressure of 50 bars or under at 300 deg K.

41152 Advanced fuels for inertial confinement. McNally, J.R. Jr.; Sharp, R.D. (Oak Ridge National Lab., Tenn. (USA)). *Nucl. Fusion;* **16**: No. 5, 868-870(1976).

Letter-to-the editor.

41153 Fusion fuel pellet and method for its fabrication. Henderson, T.M.; Rensel, W.B.; Wuttke, G.H. (to KMS Fusion, Inc). German(FRG) Patent 2,548,445/A/. 26 May 1976. 9p. (In German). 2 figs.

In order to improve the heat transfer properties of fusion fuel pellets, it is proposed to chose a hollow microsphere of glass as pellet and to introduce into it a mixture of fusion fuel and a gas with better heat transfer properties than the fusion fuel, by means of diffusion. If the pellets are cooled down to very low temperatures, the fuel is condensing on the inner walls of the pellet and can be frozen out, thus being available as solid fuel. The patent proposes to use helium as the gas for this process.

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

REFER ALSO TO CITATION(S) 42074

PHYSICAL ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 41908, 42310

RADIATION SOURCES

DESIGN AND FABRICATION

41154 Californium-252 fission spectrum irradiation facility for neutron reaction rate measurements. Grundl, J.A. (National Bureau of Standards, Washington, DC); Spiegel, V.; Eisenhauer, C.M.; Heaton, H.T. II; Gilliam, D.M.; Bigelow, J. *Nucl. Technol.;* **32**: No. 3, 315-319(Mar 1977).

Spontaneous fission sources of ^{252}Cf, lightly encapsulated and with neutron source strengths approaching 10^{10} n/s, have been developed especially for integral cross-section measurements and neutron reaction rate calibrations. An irradiation facility at the National Bureau of Standards makes use of these sources in two well-investigated geometries. A free-field neutron flux in the range of 10^7 n/(cm^2 s) (10^5 n/mm^2.s) and fluences of up to 10^{13} n/cm^2 (10^{11} n/mm^2) are established at the facility based only on a distance measurement and the absolute source strength of the national standard Ra-Be photoneutron source. The error in the ^{252}Cf source strength (+-1.1 percent) dominates the total free-field flux uncertainty of +-1.4 percent (1 sigma). Neutron scattering effects in the source capsule and support structures and neutron return from concrete and earth boundaries have been calculated and investigated experimentally. In the worst case, they contribute +-0.7 percent to the total flux response uncertainty for all observed neutron reaction rates, including those with sensitivity to low-energy neutrons.

ISOTOPIC POWER SUPPLIES

DESIGN AND FABRICATION

41155 (BNWL—1845-31) Quarterly report on the strontium heat source development program and the beneficial isotopes utilization program, Division of Nuclear Research and Application for October—December 1976. Fullam, H.T.; Jarrett, J.H. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jan 1977. Contract EY-76-C-06-1830. 31p. Dep. NTIS, PC A03/MF A01.

At Hanford, strontium is separated from the high-level waste, converted to the fluoride, and doubly encapsulated in small, high-integrity containers for subsequent long-term storage. The fluoride conversion, encapsulation and storage take place in the Waste Encapsulation and Storage Facilities (WESF). The encapsulated strontium fluoride represents an economical source of ^{90}Sr if the WESF capsule can be licensed for heat source applications under anticipated use conditions. The objectives of this program are to obtain the data needed to license $^{90}SrF_2$ heat sources and specifically the WESF $^{90}SrF_2$ capsules. Research progress is reported on: (1) chemical and physical properties of $^{90}SrF_2$; (2) $^{90}SrF_2$ compatibility studies; and (3) capsule qualification and licensing. In the Beneficial Isotopes Utilization Program research progress is reported on isotopes availability, cold regions applications, WESF product utilization, and general applications of radioisotopes in army thermal systems. (TFD)

41156 Fracture behavior of a Pt—30% Rh—8% W alloy between room temperature and 1300°c. Rohr, D.L.; Hecker, S.S. (Univ of Calif, Los Alamos Sci Lab, NM). *Microstruct. Sci.;* **4**: 245-262(1976).

Pt-30% Rh-8% W alloys are being considered for structural applications in Radioisotopic Thermoelectric Generators (RTG's) for space nuclear power systems. To determine materials compatibility and structural properties thermally exposed tensile specimens were tested at temperatures between room temperature and 1300°C. The specimens had been exposed as control specimens or in contact with graphite or $^{238}PuO_2$ (the radioisotopic fuel) at 900 and 1100°C for 2000 and 8000 hr. The fracture behavior proved most interesting, being brittle and intergranular below 250°C and between 900 and 1100°C, and ductile transgranular at 250-800°C and above 1100°C. Auger Electron Spectroscopy of freshly fractured specimens revealed segregation of phosphorus up 11 at .% at the grain boundaries which appears to be responsible for the low temperature brittle fracture. Exposure to $^{238}PuO_2$ further embrittled this alloy at low temperatures. The high temperature brittle fracture behavior resembled that caused by liquid metal embrittlement, possibly from a low-melting Rh-Pt-P eutectic.

41157 Nuclear powered satellite design for shuttle launches. Kaplan, M.H. University Park, PA; Pennsylvania State Univ. (1977). 7p.

From AIAA conference on the future of aerospace power systems; St. Louis, MO, USA (1 Mar 1977).

Developing technology and the transition period of the late 1970's from expendable launchers to reusable space shuttles and from single satellite designs to standardized and modularized configurations represent a strong motivation and unique opportunity to actively investigate new applications of nuclear power for satellites. Recently, the U.S. Energy Research and Development Administration has initiated studies on various aspects of nuclear powered satellite design and mission problems in order to establish the viability of using such power supplies for future space missions. The work reported here deals primarily with the 100 to 2,000 We power range and consists of many faceted effort. Spacecraft design problems associated with integration of nuclear power are addressed. Launch constraints and interfaces with respect to the space shuttle and those peculiar to nuclear powered vehicles are considered. Design of isotope power generators from an overall mission point of view is considered. A point design exercise is included to illustrate a specific application. Three primary aspects of nuclear powered satellite philosophy are considered. These include space shuttle capabilities, spacecraft design, and power supply design.

HYDROGEN

41158 (N—76-24726) Production and utilization of alternative secondary energy carriers. Nitsch, J. (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Lampoldshausen (Germany, F.R.). Inst. fuer Chemische Raketenantriebe). 24 Apr 1975. 34p. (DLR-IB—456-75/5). NTIS $4.00.

Planned projects are outlined. Hydrogen, the most promising and most universal energy carrier, is used as an example. Primary activities considered are: investigation of combined thermochemical-electrolytical cycling processes, storage of hydrogen in low temperature absorbers and hydrogen-oxygen fed cycling process for energy storage and peak current generation. Supplementary activities are: the hydrogen aircraft, investigations of the liquid hydrogen tank/engine in an automobile, and safety investigations with hydrogen. Planned research in the fields of alcohols and mineral oil processing is mentioned. (GRA)

PRODUCTION

41159 (N—76-24723) **Hydrogen as energy carrier. Future possibilities in the Netherlands.** (Unidynamics, Phoenix, Ariz. (USA). Research Dept.). Sep 1975. 281p. NTIS $9.25.

The application of hydrogen as carrier for thermal energy, produced by new energy sources such as nuclear reactors and wind and solar energy generators, is discussed. Topics dealt with include production, storage, transport and distribution of hydrogen, aspects of location bound use, application in transport vehicles, environmental and safety aspects, and problems in introducing hydrogen. Conclusions and recommendations for each of these topics are given and, as a general conclusion, there are thought to be wide perspectives for the use of hydrogen as carrier in the energy supply in the Netherlands. The technological problems are considered surmountable.

ELECTROLYSIS

41160 (N—76-24374) **Photoelectrolytic production of hydrogen using semiconductor electrodes. Interim report.** Byvik, C.E.; Walker, G.H. (National Aeronautics and Space Administration, Langley Station, Va. (USA). Langley Research Center). Mar 1976. 16p. (NASA-TM-X—72830). NTIS, PC A02/MF A01.

Experimental data for the photoelectrolytic production of hydrogen using GaAs photoanodes was presented. Four types of GaAs anodes were investigated: polished GaAs, GaAs coated with gold, GaAs coated with silver, and GaAs coated with tin. The maximum measured efficiency using a tungsten light source was 8.9 percent for polished GaAs electrodes and 6.3 percent for tin coated GaAs electrodes.

41161 **Will the large-scale production of hydrogen be part of the energy problem or part of its solution.** Sauter, G.D. (Univ of Calif, Livermore). *Energy Commun.;* 2: No. 6, 585-604(1976).

This paper analyzes the 'energy dynamics' of nuclear reactors as a means of generating hydrogen, focussing attention on the rate of expansion of the reactor network and the ratio of the energy required to build a reactor to the energy it produces. 5 refs.

THERMOCHEMICAL PROCESSES

REFER ALSO TO CITATION(S) 41161, 41450

COAL GASIFICATION

REFER ALSO TO CITATION(S) 40788

STORAGE

CHEMISORPTION

41162 (N—76-27667) **Investigation of metal hydride materials as hydrogen reservoirs for metal—hydrogen batteries.** Onischa. (Energy Research Corp., Danbury, Conn. (USA)). 30 Jun 1976. Contract NAS3-18557. 50p. (NASA-CR—135031). NTIS $4.00.

The performance and suitability of various metal hydride materials were examined for use as possible hydrogen storage reservoirs for secondary metal—hydrogen batteries. Lanthanum pentanickel hydride appears as a probable candidate in terms of stable hydrogen supply under feasible thermal conditions. A kinetic model describing the decomposition rate data of the hydride has been developed. (auth)

TRANSPORT

41163 (N—76-24421) **Production and transport of hydrogen slush. Final report.** Schraewer, R. (Messer Griesheim G.m.b.H., Frankfurt am Main (Germany, F.R.)). Oct 1975. 97p. (BMFT-FB-T—75-22). NTIS, PC A05/MF A01.

Sponsored by Bundesmin. Fuer Forsch. U. Technol.

Hydrogen slush, a homogeneous mixture of liquid and solid hydrogen, was discontinuously produced using vacuum pumps. Efforts with regard to a continuous production method led to the nozzle expansion method in which the amount and the fine granulation of the ice could be increased. A nuclear density measuring sensor was developed in which the weakening of the beta-radiator represents a unit of measurement for the ice portion and therefore of the slush quality. Transport tests with fresh and artificially aged slush revealed that on using small bore pipings it was possible to transport only artificially aged slush.

INDUSTRIAL AND COMMERCIAL USE

REFER ALSO TO CITATION(S) 41753

PROPERTIES

REFER ALSO TO CITATION(S) 41922

41164 (N—76-30497) **Prandtl-Meyer flow tables for parahydrogen at total temperatures from 30°K to 290°K and for nitrogen at total temperatures from 100°K to 300°K at total pressures from 1 atm to 10 atm.** Haut, R.C.; Adcock, J.B. (Minneapolis-Honeywell Regulator Co., Minn. (USA)). Aug 1976. 194p. (NASA-TM-X—73932). NTIS, PC A09/MF A01.

The dependency of Mach number on the Prandtl-Meyer function was numerically determined by iterating the Prandtl-Meyer function and applying the Muller method to converge on the Mach number for flows in cryogenic parahydrogen and nitrogen at various total pressures and total temperatures. The results are compared with the ideal diatomic gas values and are presented in tabular form. (auth)

41165 (N—76-30504) **Experimental apparatus to study forced convection heat transfer to supercritical cryogenic hydrogen.** Beech, J.C.; Ziebland, H. (Explosives Research and Development Establishment, Waltham Abbey (UK)). 1975. 44p. (ERDE-TN—84;BR—51432). NTIS, PC A03/MF A01.

A detailed description of the flow cycle of a test rig designed and constructed for experimental studies of the heat transfer characteristics of supercritical hydrogen (energy-rich fuel for rocket propulsion) is presented together with details of construction and instrumentation of the electrically heated, square test section and all other associated instrumentation. In view of the hazards involved in experimenting with this fluid, special attention was paid to the development of automatic control and alarm devices. Brief reference is made to a few tentative trials to prove the proper functioning of all parts of the complex equipment. Surface temperatures and heat fluxes in the rectangular cross-section of the electrically heated tubes are estimated. (Author) (GRA)

OTHER SYNTHETIC AND NATURAL FUELS

41166 **Federal fuels from biomass energy program.** Ward, R. (US Energy Res and Dev Adm, Washington, DC). *For. Prod. J.;* 26: No. 9, 60-64(Sep 1976).

Fuel from biomass, considered an indirect form of solar energy, was identified as part of an overall solar energy program. A comprehensive 5-year program of research, development, and demonstration has been developed. The major program elements include: fuels from agricultural and forestry residues, terrestrial biomass production and conversion, marine biomass production and conversion, and basic and advanced research. 6 refs.

PROPERTIES

REFER ALSO TO CITATION(S) 40807

41167 (AD-A—026638) **Cn production efficiencies from active nitrogen-hydrocarbon flames. Interim report.** Capelle, G.A.; Suchard, S.N. (Aerospace Corp., El Segundo, Calif. (USA). Aerophysics Lab.). 1 Jun 1976. Contract F04701-75-C-0076. 29p. NTIS $4.00.

Various hydrocarbons have been reacted with active nitrogen in a supersonic flow system. The resulting chemiluminescence was invariably dominated by CN A doublet Pi and B doublet sigma(+) to X doublet sigma(+) emission. The intensity of this emission and the excited-state vibrational temperatures were strongly dependent upon the reactant hydrocarbon. Photon yields as high as 18.5% were measured for CN A doublet Pi to X doublet sigma (+) emission when C2F4 was used as a reactant, which makes this system a very

promising chemically pumped laser. Calculations have shown that, if the populations in the electronically excited states can be vibrationally cooled, it should be possible to achieve positive gain in the system. (GRA)

41168 Kinetics of the formation of pyrocarbon from methane. Tesner, P.A.; Golovina, N.B.; Gorodetskii, A.E.; Polyakova, M.M. (All-Union Sci-Res Inst of Nat Gases, USSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 1, 108-114(1976).

The kinetics of the thermal decomposition of methane on quartz has been studied in the temperature range from 800 to 1100°C and the pyrocarbon produced has been studied under the electron microscope. It has been shown that the dimensions of the crystallites of a stationary film of pyrocarbon decrease with a rise in the temperature. A mechanism is proposed for the growth of a pyrocarbon film which is based on ideas of the decomposition of methane molecules on the surface of seeds and their growth in the basis plane until they come into contact with one another accordance with Kolmogorov's scheme. The activation energies of the over-all process of the growth of the film, of the formation of seeds, and of their growth are, respectively, 65, 83, and 55 kcal/mole. 13 refs.

PREPARATION

41169 (FE—2203-12) **Investigation of converting the product of coal gasification to methane by the action of microorganisms: Phase I. Third quarterly report, May 1, 1976—August 1, 1976.** Augenstein, D.C.; Costa, J.; Wise, D.L. (Dynatech R/D Co., Cambridge, Mass. (USA)). 16 Sep 1976. Contract EX-76-C-01-2203. 169p. Dep. NTIS $6.75.

Experiments continued with two CSTR fermenters operated at atmospheric pressure and one at high pressure, now 450 psig. Experiments were also conducted in stationary flasks to study utilization of carbon monoxide. In experiments in the atmospheric pressure units, it was found that either microorganism recycle or thermophilic operation were capable of substantially increasing productivity, to levels over 100 VVD. Continuous methane production has now been obtained for over one month at 450 psig in the high pressure unit. Carbon monoxide utilization has now been demonstrated in three different experiments, although at low rates. Flask experiments are giving evidence for selection of a culture that utilizes CO more readily. In experiments with hydrogen sulfide, it has been found that increased H_2S in the feed initially has a deleterious effect on the fermentation. However with continued exposure, acclimation of the culture occurs, and production rates return to usual. An engineering and economic analysis has been carried out for biomethanation, and results compared with those for the catalytic process. Results show that the biomethanation offers potential for significant reductions in capital cost relative to catalytic methanation.

CHEMICAL SYNTHESIS

41170 (AD-A—034675) **Mass-spectrometric measurements of enhanced methanation activity over cobalt and nickel foils. Interim report.** Palmer, R.L.; Vroom, D.A. (IRT Corp., San Diego, Calif. (USA)). 20 Dec 1976. Contract N00014-72-C-0247. 20p. (INTEL—8005-007). NTIS, PC A02/MF A01.

The kinetics of methane synthesis from H_2/CO mixtures has been studied over Ni, Co, and Fe foils. The gas composition of a flowing reaction cell was analyzed using a differentially pumped, modulated mass-spectrometer. Ni and Co foils that have been previously oxidized, and then reduced in H_2 at 525-600°K show a surprisingly high and specific catalytic activity for methane formation. No unusual activity was observed over iron for any of the surface treatments tried here. Evidence is also presented to support a mechanism for this highly specific reaction involving a labile surface carbon atom intermediate.

PREPARATION FROM WASTES OR BIOMASS

41171 (AD-A—034359) **Production of hydrocarbon-type synthetic fuel from wood.** Gardner, L. (National Research Council of Canada, Ottawa, Ontario). Sep 1976. Contract DA-49-106-qm-1. 14p. NTIS, PC A02/MF A01.

Summary in French.

As the world petroleum reserves become depleted considerable attention is being focussed on alternate sources of energy. In the short term, at least, the synthesis of hydrocarbon fuels similar in composition to present petroleum based fuels is the preferred choice for automotive use. Synthetic fuels of this type can be produced from coal, however the possibility of producing a similar fuel from wood has not been considered to any extent. A theoretical study of the production of fuels from wood via pyrolysis and the Fischer-Tropsch synthesis has therefore been made. The results of this study, as presented in this report, indicate that although technically feasible the production of such as fuel is financially and energy-wise uneconomical.

41172 Fluidized bed solids waste gasifier. Liu, M.S.; Serenius, R. (BC Res, Vancouver). *For. Prod. J.;* **26**: No. 9, 56-59(Sep 1976).

A process of converting wood waste to a low-Btu gas and charcoal in a fluidized-bed gasifier is described. The process consists of continuously feeding shredded wood waste into the gasifier, which contains a bed of hot glowing charcoal. Air is used as a fluidization medium and also supplies oxygen required for the gasification process. The process is thermally self-sustaining. The low-Btu gas normally contains 150 to 200 Btu/sdcf and is a clean source of energy. Charcoal can be briquetted or processed further to become activated carbon. The performance of a pilot scale gasifier is presented. Only the gasification aspects are covered. 2 refs.

PROPERTIES

REFER ALSO TO CITATION(S) 41030

CHEMICAL SYNTHESIS

REFER ALSO TO CITATION(S) 40788

PREPARATION

41173 Ways of reducing heat losses in the regeneration of alkali absorbents. Gridin, I.D.; Volodin, N.I.; Afanas'ev, N.A.; Uvarova, V.I. *Khim. Prom-st. (Moscow);* No. 6, 43-45(1975). (In Russian).

A number of schemes are described for removing carbon dioxide from ammonia synthesis gas by an aqueous solution of monoethanolamine. One scheme, in particular, is recommended which ensures total elimination of the heat losses caused by throttling. In the proposed scheme the process of recovery of the heat of the regenerated absorbent coincides with the process of desorption of the acid gas (the heat-transfer surface is located inside the regenerator).

SOLID WASTE FUELS

REFER ALSO TO CITATION(S) 41197

41174 (AD-A—034416) **Technical evaluation study: solid waste as a fuel at Ft. Bragg, N. C. Final report.** Hathaway, S.A.; Woodyard, J.P. (Army Construction Engineering Research Lab., Champaign, Ill. (USA)). Dec 1976. 56p. (CERL-TR-E—95). NTIS, PC A04/MF A01.

This study investigated the technical and economic feasibility of using refuse as an energy resource at Ft. Bragg, NC. The technically proven system found to be most cost-effective uses mixed solid waste generated at both military (Ft. Bragg, Pope AFB) and civilian (City of Fayetteville) sources in the region. Refuse is delivered to an energy-recovery plant near the 82nd Airborne Division Heating Plant at Ft. Bragg, where it is processed into a refuse-derived fuel (RDF) by shredding and magnetic removal of ferrous materials. RDF is temporarily stored in a hopper until fed by screw conveyor to the incinerator feed hopper, from which it is ram-fed into the furnace. The stoking mechanism is a three-flight double reciprocating grate. Saturated steam at 160 psig is produced in the boiler section after furnance and fed to the main header of the nearby steam plant for distribution. Nearly 65,000 tons of refuse is processed annually. Review of alternative system reveals that if the civilian sector chooses not to participate in the plan, energy recovery from the military refuse alone is still economically attractive.

41175 (PB—258071) **Fluidized vortex incineration of waste. Final report May 70—Aug 74.** Holman, J.P.; Razgaitis, R.A. (Southern Methodist Univ., Dallas, Tex. (USA). Dept. of Civil and Mechanical Engineering). Aug 1976. 337p. NTIS $10.00.

The report gives results of an experimental investigation of an incineration concept utilizing fluidized wastes in a confined vortex flow with simultaneous heat recovery. The incinerator consisted of a vortex combustion chamber and a cooled vertical furnace column 5 feet long and half a foot in diameter. (No transition section was used.) The vortex incinerator was operated using propane, sawdust/propane, and sawdust. The principal experiments were performed using propane at air/fuel ratios and total mass flow rates (in lbs per hour) in three combinations: 15 and 125, 20 and 220, and 20 and 280. Radial temperature profiles and heat transfer to the wall of the vortex tube were measured as a function of air/fuel ratio, vertical position, total gas flow rate, and inlet/outlet configurations. Maximum energy fluxes experienced were on the order of 37,000 Btu/hr-sq ft. A helicoidal flow-model correlation was developed which was

about 4 times that predicted for the Colburn j-Factor using the Reynolds analogy for fluid friction for turbulent flow past a flat plate. (GRA)

41176 Fluidised combustion. Hill, B.J. (Combust Syst Ltd). *Energy Dig. (London)*; 5: No. 4, 25-30(Aug 1976).

In fluidized combustion, solid, liquid or gaseous fuel is injected into and burned in a fluidized bed of inert particles which can be composed of crushed refractory, sand, limestone, dolomite or any other suitable material and in the case of coal firing, ash from previously burned coal. The particles should have good resistance to attrition so as to minimize the elutriation and the need to constantly feed in new material to maintain bed level. The combustion bed, which does not normally have more than 0.5% by weight of carbon at any one time, is kept within the temperature range 750-950°C, depending on the particular fuel, by extracting heat through tubes immersed in the bed or passing excess air through the bed or a combination of both. This low combustion temperature prevents the formation of 'clinker', limits the formation of corrosive substances which attack metal surfaces in conventional plant and limits the formation of nitrogen oxides. Furthermore it is the temperature range within the reaction of SO_2 with limestone or dolomite is most effective. Fuel and inert particle size is generally within the range 1/4 in. to 0, which reduces the cost of coal preparation when compared with pulverized-fuel plant. The inherent characteristics of fluidized combustion make it ideally suited to the burning of sewage sludge, oily wastes, refinery sludges, highly volatile organic wastes, varnish or paint residues and size-classified municipal waste.

HYDRO ENERGY

RESOURCES AND AVAILABILITY

REFER ALSO TO CITATION(S) 41557

PLANT DESIGN AND OPERATION

REFER ALSO TO CITATION(S) 41561, 41562, 41564

41177 Analysis of total pump-turbine system including pipelines. Araki, M.; Kuwabara, T. (Hitachi Works, Jpn). *Hitachi Hyoron;* 24: No. 5, 217-223(May 1975).

Described is a dynamic characteristics analysis program recently developed for application to two or more pump-turbines connected to a complicated water passage system. This comprehensive program covers the water-hammer phenomenon originating in the water systems on both penstock and tailrace sides, the discharge of each pump-turbine, the torque characteristics, tie-line characteristics, and the speed governor; and it simulates all the performance conditions from starting through stopping of each pump-turbine by digital computers. Not only can the program be applied to predictions of actual on-site pump-turbine performance but it is also capable of optimum design of a total pump-turbine plant meeting civil engineering and other requirements. Further, for analysis of the water-hammer phenomenon, the method of characteristics is used which takes into consideration both pipeline slope and pipeline friction.

41178 About the proportioning of the water-flows for running water hydroelectric stations. Pavone, G. (AEI, Naples, Italy). *Elettrotecnica;* 62: No. 8, 667-670(Aug 1975). (In Italian).

As is known, the running water hydroelectric stations are generally proportioned to a greater water-flow than that of the minimum, therefore they are subjected to a longer or shorter action time with a low water-flow. In such a case a previous hydrological study for the best choice of the greatest derivable water-flow is necessary for establishing the peculiarities of the stations. The essential methods to proportion the water-flows are reviewed, and a new method is proposed to determine the highest derivable water-flow. This method is particularly adapted for those rivers whose water-flows are statistically distributed with a great dispersion and for which the actual proportioning methods are not able to give a quick solution to the problem. An example of the proposed method is given.

SOLAR ENERGY

REFER ALSO TO CITATION(S) 41656

RESOURCES AND AVAILABILITY

41179 Method for estimating hourly averages of diffuse and direct solar radiation under a layer of scattered clouds. Wesely, M.L.; Lipschutz, R.C. (Argonne Natl Lab, Ill). *Sol. Energy;* 18: No. 5, 467-473(1976).

The purpose of this paper is to provide a simple procedure for estimating values of diffuse component and direct component that can be used in comparisons of the theoretical performances of solar collectors of different designs. The amount of solar energy collected at the focal point of a Sun-tracking parabolic reflector is extremely sensitive to the direct-beam attenuation caused by clouds. On the other hand, the collection by flat-plate receptors is less sensitive to such shading because the decrease of the direct component is accompanied by increased diffuse radiation. 10 refs.

ENVIRONMENTAL ASPECTS

41180 (ERDA—77-47/5) **Solar program assessment: environmental factors.** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Solar Energy). Mar 1977. 71p. Dep. NTIS, PC A04/MF A01.

This report presents and prioritizes the major environmental, safety, and social/institutional issues associated with the further development of Solar Total Energy Systems (STES). Solar total energy systems represent a specific application to the Federally-funded solar technologies. To provide a background for this analysis, the basic concepts of STES are reviewed, as are their resource requirements. The potential effects of these systems on the full range of environmental concerns (e.g., air and water quality, biosystems, safety, social/institutional structures, etc.) are then discussed in terms of both their relative significance and possible solutions. Although the development of STES will contribute to environmental problems common to any construction project or energy-producing technology (i.e., air pollutants resulting from cooling tower "drift"), only those impacts unique to the solar portion of the technology are discussed in depth. Finally, an environmental work plan is presented, listing R and D proposals and a NEPA work plan that might help clarify and/or alleviate specific environmental problems.

SOLAR ENERGY CONVERSION

PHOTOVOLTAIC CONVERSION

REFER ALSO TO CITATION(S) 41228

41181 (ERDA/JPL/954373—76/5) **Heat exchanger-ingot casting/slicing process. Silicon sheet growth development for the large area silicon sheet task of the low cost silicon solar array project. Fifth quarterly progress report, September 25, 1976—December 16, 1976.** Schmid, F.; Reynolds, B. (Crystal Systems, Inc., Salem, Mass. (USA)). 20 Dec 1976. Contract NAS-7-100-954373. 58p. Dep. NTIS $4.50.

Casting experiments during the quarter were directed towards determining the maximum growth rate, characterizing the mode of heat transfer to the gaseous helium in the heat exchanger, developing a sintered crucible coating, and determining the cause of a SiC deposition on the melt stock prior to melting. Also, silicon crystal slicing tests using diamond-impregnated wire blades were continued. Results are presented and discussed. (WHK)

41182 (ERDA/JPL/954374—76/4) **Slicing of silicon into sheet material. Silicon sheet growth development for the large area silicon sheet task of the low cost silicon solar array project. Third quarterly report, September 20, 1976—December 19, 1976.** Holden, S.C. (Varian Associates, Lexington, Mass. (USA). Lexington Vacuum Div.). 27 Dec 1976. Contract NAS-7-100-954374. 37p. Dep. NTIS $4.00.

The stability of tensioned blades used in multiblade sawing does not seem to be the limitation in cutting with thin blades. So far, 0.010 cm thick blades have been totally unsuccessful. Recently, 0.015 cm blades have proven successful in wafering, offering an 0.005 cm reduction in the silicon used per slice. The failure of thin blades is characterized as a possible result of blade misalignment or from the inherent uncontrollability of the loose abrasive multiblade process. Corrective procedures will be employed in the assembly of packages to eliminate one type of blade misalignment. Two ingots were sliced with the same batch of standard silicon carbide abrasive slurry to determine the useful lifetime of this expendable material. After 250 slices, the cutting efficiency had not degraded. Further tests will be continued to establish the maximum lifetime of both silicon carbide and boron carbide abrasive. Electron microscopy will be employed to evaluate the wear of abrasive particles in the failure of abrasive slurry. The surface damage of silicon wafers has been characterized

as predominantly subsurface fracture. Damage with No. 600 SiC is between 10 and 15 microns into the wafer surface. This agrees well with previous investigations of damage from silicon carbide abrasive papers.

41183 (ERDA/JPL/954458—76/3) **Accelerated/abbreviated test methods, study 4 of task 3 (encapsulation) of the low-cost silicon solar array project. Third quarterly progress report, October—December 1976.** Kolyer, J.M. (Rockwell International Corp., Anaheim, Calif. (USA). Autonetics Div.). 5 Jan 1977. Contract NAS-7-100-954458. 36p. Dep. NTIS $4.00.

Physical properties of materials change on exposure to the weather. Hence, it is feared that many solar cell encapsulants cannot provide sufficient protection for 20 years outdoors. To predict how long and how well the encapsulants can perform, it is necessary to have a mathematical model for degradation. Based on literature data, the Weibull equation seems suitable. Then, in principle, by inserting measured values for the rate constants into this equation, any property can be predicted as a function of time. Phoenix, Arizona and Miami, Florida were selected as suitable sites for our weathering tests. Complete weather data and outdoor exposure services are available at both locations. Encapsulated test specimens (UTS's) were placed outdoors on racks and are being returned to our laboratory at predetermined time intervals. Upon receipt, they are being examined chemically, physically and electrically to establish the degradation rate and suggest probable mechanisms. Similar test specimens are being exposed in a weathering chamber in the laboratory. The factors being studied are light intensity, temperature, and humidity in 24 combinations. Degradation rates are being measured and will be compared with those found for outdoor exposure. The indoor and outdoor tests are proceeding as planned. The principal mode of deterioration observed so far is a progressive yellowing of the encapsulant film. This effect is due to photochemical reactions near the surface. This change in optical transmittance is one property being used to establish degradation model and a methodology for predicting the useful life of encapsulation systems. No failures have occurred in the test specimens due to lead/contact corrosion or to adhesive failure/delamination.

41184 (ERDA/JPL/954475—76/3) **Large area Czochralski silicon. Quarterly report No. 3.** Rea, S.N.; Gleim, P.S. (Texas Instruments, Inc., Dallas (USA)). Dec 1976. Contract NAS-7-100-954475. 55p. Dep. NTIS $4.50.

The Varian 12-kg puller was made fully operational during the quarter. Several trial 12-cm crystals have been pulled both from recycle silicon and new polysilicon. Average pull rates of 8-10 cm/h were achieved versus the program goal of 12 cm/h. Two attempts were made to hot-charge into an 8-kg crucible using chunk polycrystalline silicon. Although these attempts were unsuccessful due to excessive melt oxidation, the concept of using chunk poly appears sound provided an airtight feed mechanism is used. Design of an airtight nugget polysilicon feeder for use on multicharge runs was completed. Multiblade slicing work continued with the optimal slurry flow experiment being repeated using 400-grit B_4C abrasive in the usual 240 g/l slurry mixture. Results confirmed the previous observation that a slurry flow rate around 5 ml/s is optimal. Several sawing experiments were performed with crystal spinning employed to enhance cutting rates. Results indicate a 4 to 5 times increase in cutting rate can be achieved on the multiblade saw with crystal spin. However, the practical application of crystal spinning offers a difficult technical challenge to reduce slice breakage, kerf, and blade wear. Several experiments with diamond-plated blades in the multiblade saw were completed. Cutting rates for stationary crystal were disappointing—being equal, at best, to those observed with B_4C abrasive slurry. With spinning crystal, however, diamond cutting rates were the best achieved to date. A 76-mm crystal was sawed down to a 19-mm core in 2.5 h for an average cutting rate of 23 mm/h. Saw yield was 90 percent on the spinning run. The economics of the Czochralski process were reexamined in view of current and projected information regarding crystal growth and wafering. Sheet cost in the $30-37/m^2 range looks achievable for the longer term.

41185 (N—76-27586) **Thermal vacuum accelerated life test of the unit qualification model msds 3 marconi low speed mechanism.** Appleton, D.A. (National Centre of Tribology, Risley (UK). European Space Tribology Lab.). 1975. 22p. (ESRO-ESTL—17;ESA-CR(P)—799). NTIS $3.50.

Subm-Sponsored by ESA.

The thermal vacuum accelerated life test of a solar array unit qualification mechanism (MSDS 3) is described. Most of the test was conducted with the shaft of the mechanism rotating at one revolution per hour, which is 24 times normal speed. The test was conducted at two different temperature conditions, and included additional thermal cycling of the shaft temperature to simulate conditions of earth eclipse of a satellite in a geostationary orbit. Throughout the test there was no change in the motor power required to drive the shaft, and the electrical noise levels on the slip rings showed no significant deterioration.

41186 (N—76-28645) **The optimization of Ga(1-x)Al(x)As-GaAs solar cells for air mass zero operation and a study of Ga(1-x)Al(x)As-GaAs solar cells at high temperatures, Phase 1. Final report.** Hovel, H.J.; Woodall, J.M. (Thomas J. Watson Research Center, Yorktown Heights, N.Y. (USA)). 1976. Contract NAS1-12812. 70p. (NASA-CR—145008). NTIS $4.50.

The three types of solar cells investigated were: (1) one consisting of a nGaAs substrate, a Zn doped pGaAs region, and a Zn doped Ga(1-x)Al(x)As layer, (2) one consisting of an nGaAs substrate, a Ge doped pGaAs region, and a pGa(1-x)Al(x)As upper layer, and (3) one consisting of an n+GaAs substrate, an nGa(1-x)Al(X)As region, a pGa(1-x)Bl(X) As region, and a pGa(1-y)Al(y)As upper layer. In all three cases, the upper alloy layer is thin and of high Al composition in order to obtain high spectral response over the widest possible range of photon energies. Spectral response, capacitance-voltage, current-voltage, diffusion length, sunlight (or the equivalent)-efficiency, and efficiency-temperature measurements were made as a function of device parameters in order to analyze and optimize the solar cell behavior.

41187 (N—76-28651) **Conceptual approach study of a 200-watt-per-kilogram solar array. Quarterly report.** Stanhouse, R.W.; Fox, D.; Wilson, W. (General Electric Co., Philadelphia, Pa. (USA). Space Div.). 15 Jul 1976. Contracts NAS7-100;JPL-954393. 102p. (NASA-CR—148505). NTIS $5.50.

Solar array candidate configurations (flexible rollup, flexible flat-pact, semi-rigid panel, semi-rigid flat-pack) were analyzed with particular attention to the specific power (W/kg) requirement. Two of these configurations (flexible rollup and flexible flat-pack) are capable of delivering specific powers equal to or exceeding the baseline requirement of 200 W/kg. Only the flexible rollup is capable of in-flight retraction and subsequent redeployment. The wrap-around contact photovoltaic cell configuration has been chosen over the conventional cell. The demand for ultra high specific power forces the selection of ultra-thin cells and cover material. Based on density and mass range considerations, it was concluded that 13 micrometers of FEP Teflon is sufficient to protect the cell from a total proton fluency of 2(10 to the 12th power) particles/sq cm over a three-year interplanetary mission. The V-stiffened, lattice boom deployed, flexible substrate rollup array holds the greatest promise of meeting the baseline requirements set for this study.

41188 (N—76-30657) **Results from the IMP-J violet solar cell experiment and violet cell balloon flights.** Gaddy, E.M. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Feb 1976. 11p. (NASA-TM-X—71168;X—711-76-29). NTIS $3.50.

The IMP-J violet solar cell experiment was flown in an orbit with mild thermal cycling and low hard particle radiation. The results of the experiment show that violet cells degrade at about the same rate as conventional cells in such an orbit. Balloon flight measurements show that violet solar cells produce approximately 20% more power than conventional cells.

41189 (PB—255903) **Development of 20% efficient solar cell. Final project report 1 Jun 74—31 Aug 75.** Lindmayer, J. (Solarex Corp., Rockville, Md. (USA)). Oct 1975. 92p. (NSF/RANN/SE/GI—43090/FR/75/2). NTIS $5.00.

SEe also Quarterly progress rept. No. 3, PB—239280.

The objective of this project is to increase the terrestrial efficiency of silicon solar cells to 20%. The gain in efficiency is to be obtained by improving the optical coupling, the current, the photovoltage, and the fill factor. In order to improve these parameters, extensive theoretical and experimental work is required to relate these quantities to the basic properties of silicon, the other materials used, and to their interactions. The better understanding of the junction properties has resulted in over 600 mV of photovoltage and nearly 80% fill factor, all significant improvements in the state of art.

41190 (PB—256254) **Ternary compound thin film solar cells. Quarterly report No. 3, 1 Mar—31 May 76.** Kazmerski, L.L. (Maine Univ., Orono (USA). Dept. of Electrical Engineering). Jun 1976. Contract NSF-AER75-19576. 40p. (NSF/RANN/SE/AER—7519576/PR/75/3). NTIS $4.00.

See also report dated Mar 76, PB—253344.

The status of the $CuInSe_2$/CdS heterojunction is discussed. An efficiency of 5.7% is reported for a device illuminated through the CdS layer. I-V and spectral response characteristics are presented. The first thin film $CuInS_2$ homojunction photovoltaic device is also reported. Device fabrication and characteristics are discussed. The production of an epitaxial thin film $CuInS_2$ single crystal Si photovoltaic junction with 4.9% efficiency is reported. Photoconductive properties of the ternary thin films are indicated. The temperature dependences of the energy gaps of $CuInS_2$, $CuInSe_2$ and $CuInTe_2$ thin films are derived from photoconductivity spectral response measurements. Defects in the chalcopyrite crystal structure are discussed. Dislocation properties are indicated for edge, screw and mixed types.

41191 (PB—258493) **High-efficiency thin-film GaAs solar cells. Interim report No. 2, 1 Apr—30 Jun 76.** Stirn, R.J.; Yeh, Y.C.M.; Ernest, F.P. (Jet Propulsion Lab., Pasadena, Calif. (USA)). Jul 1976. 55p. NTIS $4.50.

See also Interim report No. 1, PB—255821.

A program was begun to investigate the feasibility of growing large grain polycrystalline GaAs by chemical vapor deposition on recrystallized Ge films, to fabricate AMOS (Antireflection-Coated Metal-Oxide-Semiconductor) solar cells on the films, and to further investigate the physics of AMOS cells on single crystals. During the last six months progress has been made in obtaining reproducibly high open-circuit voltages on oxidized single-crystal GaAs before contacting with grids or depositing AR coatings. Chemical characterization of the different oxidized surfaces using X-ray Photoelectron Spectroscopy (XPS) shows that the oxidation of the As atoms seems to be one of the key processes required for proper film preparation. Application of gold to the oxide film results in gold reaction with the film and apparent modification of the relative amounts of As(3+) to As(5+) in the oxide. Baseline and AMOS Schottky barrier solar cells have been fabricated on polished wafers of polycrystalline GaAs with relatively high doping levels. Ge films recrystallized to date with focused IR line heaters melted over too large an area for zone recrystallization. A 10-watt CW Nd/YAG laser has been ordered in order to accomplish much finer zones of melting by line focusing with cylindrical lenses.

41192 (N—76-28653) **Solar cells.** Translated from *Neue Zuer. Ztg.;* No. 287, 23-24(Jun 1974). 17p. (In German). (NASA-TT-F—16744). NTIS $3.50.

Solar cells which directly convert the incident light energy of the sun into electrical current are described. Cost factors are considered.

41193 (N—76-28644) **Physical characterization of silicon solar cells by determination of spectral response.** Fabre, E.; Mautref, M. Translated from *Acta Electron.;* **18**: 331-338(Oct 1975). 18p. (NASA-TT-F—17138). NTIS $3.50.

Spectral response measurements are shown to be useful tools for assessing solar cells. Data are acquired on minority carrier diffusion length and on the entrance window of the cell, i.e., on the main parameters which govern the overall conversion efficiency. Trap saturation phenomena which lead to an improvement of the apparent minority carrier diffusion length are measured. An electrolytic cell is used to study the influence of different parameters which can affect the shortcircuit current and to establish the best solar cell fabrication process.

41194 (N—76-29705) **Simulation of silicon solar cells and comparison with experimental results.** Michel, J.; Mircea, A. Translated from *Acta Electron.;* **18**: No. 4, 311-320(Oct 1975). 42p. (NASA-TT-F—17137). NTIS $4.00.

A detailed description of the physical-mathematical model developed for computer simulation of the operation of photovoltaic cells is given. This program is particularly flexible and implies little working cost. Its use in analyzing the effect of numerous parameters on the conversion output of silicon cells with an n-p and n-p-p structure is described. It is shown that it is possible to achieve better conversion outputs with thin cells (50 to 100 micrometers) than with cells of the usual thickness (300 micrometers).

41195 **Dark currents in cuCu_2S-CdS single crystal heterojunctions--consequences for photocells.** Martinuzzi, S.; Mallem, O.; Cabot, T. (Univ of Aix-Marseille, Fr). *Phys. Status Solidi (a);* **36**: No. 1, 227-234(Jul 1976).

An investigation is made of the dark-current conduction processes in Cu_2S-CdS single crystal heterojunctions. The reverse currents are multistep tunneling currents as in thin film Cu_2S-CdS photocells, but the number of required steps is smaller. For the forward currents, thermal currents over the barrier are dominant above 300 K, and tunneling currents appear only at lower temperatures. It follows that crystallographic defects enhance the tunneling currents, and that high efficiency solar photocells have to be made with recrystallized CdS layers. A band profile is given, and a photovoltaic mechanism is proposed for the Cu_2SCdS heterojunctions. 19 refs.

THERMIONIC CONVERSION

REFER ALSO TO CITATION(S) 41662

PHOTOSYNTHETIC CONVERSION

REFER ALSO TO CITATION(S) 41166

41196 (AD-A—031163) **Feasibility of meeting the energy needs of army bases with self-generated fuels derived from solar energy plantations. Final report.** Szego, G.C. (InterTechnology Corp., Warrenton, Va. (USA)). Jul 1976. Contract DACA23-74-C-0009. 149p. (ITC—260675). NTIS $6.00.

See also Appendices, AD-A—031164.

This project thoroughly investigated the possibility of collecting and storing solar radiation in plants especially grown for their fuel value as a source of fuel on U. S. Army bases. The study investigated the merit of producing this fuel at energy plantations at or near the bases. The fuel would be used for directly fired steam generators, hot water heaters, space heaters, and cooking. The research examined the major characteristics of energy plantations; analyzed plant-matter production rates from deciduous plants; and examined fuel consumption in stationary facilities at major troop training centers. The possibilities and requirements of energy plantations at Fort Benning, Fort Leonard Wood, and at Army bases in general were detailed. It was concluded that energy plantations could be feasible at approximately 15 large Army bases and that the cost of solid fuel produced from them would be approximately $1/1 million Btu; the cost of synthetic natural gas produced from plants was determined to be approximately $3.10 to $4.20/1000 standard cu ft. Besides being a perpetually renewable fuel source, it was found that energy plantations could provide independence from other fuel sources, reduction in future environmental problems caused by present fuels, and will productively use land not now in active use.

41197 (AD-A—031211) **Feasibility of meeting the energy needs of army bases with self-generated fuels derived from solar energy plantations (Appendices D, E, F, G, and H). Final report.** Szego, G.C. (InterTechnology Corp., Warrenton, Va. (USA)). Jul 1976. Contract DACA23-74-C-0009. 313p. (ITC—260675). NTIS $9.75.

The study investigated the merit of producing fuel at energy plantations at or near the bases. The fuel would be used for directly fired steam generators, hot water heaters, space heaters, and cooking. The research examined the major characteristics of energy plantations; analyzed plant-matter production rates from deciduous plants; and examined fuel consumption in stationary facilities at major troop training centers. The possibilities and requirements of energy plantations at Fort Benning, Fort Leonard Wood, and at Army bases in general are detailed.

41198 (PB—261910) **Biological solar energy conversion: approaches to overcome yield, stability and product limitations. Progress report No. 3, 1 Apr 1976—30 Sep 1976.** Kok, B.; Fowler, C.F.; Hardt, H.H.; Radmer, R.J. (Martin Marietta Labs., Baltimore, Md. (USA)). 1976. 42p. (MML-TR—76-16c). NTIS, PC A03/MF A01.

See also PB—258850.

Studies are continuing concerning the rate inhibition induced by treating chloroplasts with glutaraldehyde. The decay of activity of isolated chloroplasts stored in the dark is studied as a function of pH. The program concerning the size of the photosynthetic unit in relation to the utilization of high light includes studies of nitrogen-starved algae and the possible role of carotenoids which accumulate in these cells. The authors detect no specific photochemical process driven by carotenoid in these organisms. Comparative studies of the light gathering systems in the bundle sheath and mesophyll cells of C_4 plants are initiated. In the mass spectrometer program, measurements are made of the affinity of O_2 for photosynthetic reducing power. Half saturation of the oxidative reaction is at approximately equal to 8% O_2. Studies of the kinetics of O_2 uptake under conditions of low CO_2 are also performed.

PHOTOVOLTAIC POWER PLANTS

41199 (PB—255646) **Assessment of cadmium sulfide photovoltaic arrays for large scale electric utility applications. Final report.** DeMeo, E.A. (Brown Univ., Providence, R.I. (USA). Dept. of Engineering). Feb 1976. 52p. NTIS $4.50.

A procedure is described which yields nominal cost and performance objectives for any solar cell material employed in noncentrating photovoltaic central stations with horizontal arrays, as functions of powerplant capital cost and structure and wiring costs. Results obtained based on subsystems cost and performance parameters judged to be realistic imply that economically competitive utility central station applications will probably require cell conversion efficiencies of 12% or greater and cell costs near one dollar per square foot. Recent results with CU_2S/CdS cells suggest that these objectives may be achievable, with the higher efficiencies probably the more difficult to attain. The analysis shows that the structure and wiring costs are likely to be of the same order of magnitude as cell costs in competitive power-plants.

SOLAR THERMAL POWER PLANTS

41200 (N—76-28647) **Cost of energy from utility-owned solar electric systems. A required revenue methodology for ERDA/EPRI evaluations.** (Jet Propulsion Lab., Pasadena, Calif. (USA)). Jun 1976. Contract NAS7-100. 89p. (NASA-CR—148493;JPL—5040-29). NTIS $5.00.

This methodology calculates the electric energy busbar cost from a utility-owned solar electric system. This approach is applicable to both publicly- and privately-owned utilities. Busbar cost represents the minimum price per unit of energy consistent with producing system-resultant revenues equal to the sum of system-resultant costs. This equality is expressed in present value terms, where the discount rate used reflects the rate of return required on invested capital. Major input variables describe the output capabilities and capital cost of the energy system, the cash flows required for system operation amd maintenance, and the financial structure and tax environment of the utility. (GRA)

TOWER FOCUS POWER PLANTS

41201 (COO/2839—1) **Heat pipe central solar receiver. Semiannual progress report, March 1, 1976—August 31, 1976.** Bienert, W.B.; Wolf, D.A. (Dynatherm Corp., Cockeysville, Md. (USA)). Nov 1976. Contract EY-76-C-02-2839. 120p. Dep. NTIS, PC A06/MF A01.

The objective of this program is the development of a solar-to-gas heat exchanger for a Central Receiver Power Plant. The concept is based on the use of heat pipes to transfer the concentrated solar flux to the gaseous working medium of a Brayton cycle conversion system. An open air cycle with recuperator and a turbine inlet temperature of 800°C (approximately 1500°F) was selected as the optimum choice. It yields a conversion efficiency of approximately 32 percent and an overall solar-to-electric efficiency of 20 percent. The light weight of gas turbine equipment opens the possibility of tower mounting the entire system. Three potential receiver configurations have been identified, two of them being of the cavity type and one being an external receiver. The required thermal diffuser heat pipes use liquid metal as the working fluid. The optimum size is approximately 5 cm in diameter and 2 to 3 m in length. The design axial heat flux is 10 MW/m² which corresponds to a heat transfer rate of 20 kW per heat pipe. The theoretical foundations of these heat pipes have been developed and subscale prototypes have been tested successfully. The radial and axial heat fluxes of the prototypes met and exceeded the requirements for the full-scale heat pipes.

41202 (PB—254399) **Closed cycle, high-temperature central receiver concept for solar electric power.** Gintz, J.R. (Boeing Co., Seattle, Wash. (USA). Boeing Engineering and Construction Div.). Feb 1976. 140p. NTIS $6.00.

The report presents the detailed results of a study into the technical feasibility of a high temperature central receiver in a solar plant employing closed cycle helium as a heat transport fluid. Feasibility was examined in terms of system life, efficiency, cost and technology requirements. These considerations are implemented in the conceptual design of a preferred receiver and its components for utilization in a solar plant of 100 megawatt electrical power output. The rationale is provided which supports the configuration, equipment arrangement, and material choices. A thermal cycling test simulating a 30-year lifetime of the receiver heat exchanger at temperatures to 816 C (1500 F) and at 34 bar (500 psi) helium pressure, confirmed the material choice. A preliminary design of a model receiver, appropriately scaled to 1 megawatt of thermal energy into the receiver, is presented as a candidate for early test. The report also contains system/supporting subsystem definition for employing the preferred central receiver in a solar plant, and recommendations for further development efforts.

SOLAR RADIATION UTILIZATION

REFER ALSO TO CITATION(S) 41657

SPACE HEATING AND AIR CONDITIONING

REFER ALSO TO CITATION(S) 41616

41203 (N—76-24702) **Development of a solar powered residential air conditioner (general optimization). Final report.** Lowen, D.J. (Chrysler Corp., Cape Canaveral, Fla. (USA)). Mar 1976. Contract NAS8-31437. 153p. (NASA-CR—144314). NTIS $6.75.

A commercially available 3-ton residential lithium bromide (LiBr) absorption air conditioner was modified for use with lower temperature solar heated water. The modification included removal of components such as the generator, concentration control chamber, liquid trap, and separator; and the addition of a Chrysler designed generator, an off-the-shelf LiBr-solution pump. The design goal of the modified unit was to operate with water as the heat-transfer fluid at a target temperature of 85 C (185 F), 29.4 C (85 F) cooling water inlet, producing 10.5 kW (3 tons) of cooling. Tests were performed on the system before and after modification to provide comparative data. At elevated temperatures (96 C, 205 F), the test results show that lithium bromide was carried into the condenser due to the extremely violent boiling and degraded the evaporator performance.

41204 (N—76-27671) **Inexpensive economical solar heating system for homes.** Allred, J.W.; Shinn, J.M. Jr.; Kirby, C.E.; Barringer, S.R. (National Aeronautics and Space Administration, Langley Station, Va. (USA). Langley Research Center). Jul 1976. 59p. (NASA-TM-X—3294;L—10451). NTIS $4.50.

A low-cost solar home heating system to supplement existing warm-air heating systems is described. The report is written in three parts: (1) a brief background on solar heating, (2) experience with a demonstration system, and (3) information for the homeowner who wishes to construct such a system. Instructions are given for a solar heating installation in which the homeowner supplies all labor necessary to install off-the-shelf components estimated to cost $2,000. These components, which include solar collector, heat exchanger, water pump, storage tank, piping, and controls to make the system completely automatic, are available at local lumber yards, hardware stores, and plumbing supply stores, and are relatively simple to install. Manufacturers and prices of each component used and a rough cost analysis based on these prices are included. This report also gives performance data obtained from a demonstration system which was built and tested at the Langley Research Center.

41205 (N—76-28652) **An investigation of the acceptance of solar heating and cooling in the housing industry in New Mexico. Final technical report, 1 Aug 1975—31 Jul 1976.** Lundahl, C.R.; Scott, J.C.; Dennis, D.M. (Western New Mexico Univ., Silver City (USA)). 31 Jul 1976. 286p. (NASA-CR—148528). NTIS $9.25.

A data base of information relating to the acceptability of solar-energy technology in the New Mexican housing industry was developed. Topics examined include: (1) the factors which influence the adoption of solar-energy systems in the New Mexican housing industry; (2) the degree of acceptability of various solar factors among New Mexican consumers, architects, contractors, financiers, energy suppliers, and governmental officials; and (3) the current attitudes toward the acceptability of solar energy factors in the New Mexican housing industry.

41206 (N—76-30653) **Development of a solar-powered residential air conditioner: economic analysis.** (AiResearch Mfg. Co., Los Angeles, Calif. (USA)). 28 Mar 1975. Contract NAS8-30758. 16p. (NASA-CR—149976;AIRESEARCH—74-10996(4)). NTIS $3.50.

The results of investigations aimed at the development of cost models to be used in the economic assessment of Rankine-powered air conditioning systems for residential application are summarized. The rationale used in the development of the cost model was to: (1) collect cost data on complete systems and on the major equipment used in these systems; (2) reduce these data and establish relationships between cost and other engineering parameters such as weight, size, power level, etc; and (3) derive simple correlations from which cost-to-the-user can be calculated from performance requirements. The equipment considered in the survey included heat exchangers, fans, motors, and turbocompressors. This kind of hardware represents more than 2/3 of the total cost of conventional air conditioners.

41207 (N—76-30655) **Development of a solar-powered residential air conditioner. Program review.** (AiResearch Mfg. Co., Los Angeles, Calif. (USA)). 8 Apr 1975. Contract NAS8-30758. 65p. (NASA-CR—149973;AIRESEARCH—74-10996(5)). NTIS $4.50.

Progress in the effort to develop a residential solar-powered air conditioning system is reported. The topics covered include the objectives, scope and status of the program. The results of state-of-art, design, and economic studies and component and system data are also presented.

41208 (N—76-30656) **Development of a solar-powered residential air conditioner.** (AiResearch Mfg. Co., Los Angeles, Calif. (USA)). 13 Jan 1975. Contract NAS8-30758. 36p. (NASA-CR—149972;AIRESEARCH—74-10996(3)). NTIS $4.00.

An extensive review of the literature was conducted which was concerned with the characterization of systems and equipment that could be applicable to the development of solar-powered air conditioners based on the Rankine cycle approach, and the establishment of baseline data defining the performance, physical characteristics, and cost of systems using the LiBr/H_2O absorption cycle.

41209 (N—76-30659) **Development of a solar-powered residential air conditioner: screening analysis.** (AiResearch Mfg. Co., Los Angeles, Calif. (USA)). 25 Jul 1975. Contract NAS8-30758. 67p. (NASA-CR—149974;AIRESEARCH—74-10996(7)). NTIS $4.50.

Screening analysis aimed at the definition of an optimum configuration of a Rankine cycle solar-powered air conditioner designed for residential application were conducted. Initial studies revealed that system performance and cost were extremely sensitive to condensing temperature and to the type of condenser used in the system. Consequently, the screening analyses were concerned with the generation of parametric design data for different condenser approaches; i. e., (1) an ambient air condenser, (2) a humidified

ambient air condenser (3) an evaporative condenser, and (4) a water condenser (with a cooling tower). All systems feature a high performance turbocompressor and a single refrigerant (R-11) for the power and refrigeration loops. Data were obtained by computerized methods developed to permit system characterization over a broad range of operating and design conditions. The criteria used for comparison of the candidate system approaches were (1) overall system COP (refrigeration effect/solar heat input), (2) auxiliary electric power for fans and pumps, and (3) system installed cost or cost to the user.

41210 (N—76-30660) **Development of a solar-powered residential air conditioner: system optimization preliminary specification.** Rousseau, J.; Hwang, K.C. (AiResearch Mfg. Co., Los Angeles, Calif. (USA)). 7 Nov 1975. Contract NAS8-30758. 134p. (NASA-CR—149975;AIRESEARCH—74-10996(8)). NTIS $6.00.

Investigations aimed at the optimization of a baseline Rankine cycle solar powered air conditioner and the development of a preliminary system specification were conducted. Efforts encompassed the following: (1) investigations of the use of recuperators/regenerators to enhance the performance of the baseline system, (2) development of an off-design computer program for system performance prediction, (3) optimization of the turbocompressor design to cover a broad range of conditions and permit operation at low heat source water temperatures, (4) generation of parametric data describing system performance (COP and capacity), (5) development and evaluation of candidate system augmentation concepts and selection of the optimum approach, (6) generation of auxiliary power requirement data, (7) development of a complete solar collector-thermal storage-air conditioner computer program, (8) evaluation of the baseline Rankine air conditioner over a five day period simulating the NASA solar house operation, and (9) evaluation of the air conditioner as a heat pump.

41211 (PB—254179) **Analysis of solar energy system for the GSA demonstration office building at Manchester, New Hampshire. Final report.** Kusuda, T.; Liu, S.T.; Bean, J.W.; Barnett, J.P. (National Bureau of Standards, Washington, D.C. (USA). Center for Building Technology). 1 Mar 1976. 34p. (NBSIR—76-1056). NTIS $4.00.

This report presents results of a study to determine the effect of solar collector sizes and the amount of storage on the overall energy consumption of a building.

41212 (PB—254493) **Assessment of a single family residence solar heating system in a suburban development setting. Monthly report.** Phillips, J.D. (Colorado Springs Dept. of Public Utilities, Colo. (USA)). 10 Jan 1976. 15p. (Phoenix—019). NTIS $3.50.

Prepared for Phoenix of Colorado Springs, Inc., Colo.

The January report is one of a series of monthly reports assessing the performance of a single family residence solar heating system in a suburban development. The solar optimized heat pump was operational throughout the month of December. The December-January 1976 Report contains experimental results of solar optimized heat pump operation.

41213 (PB—254494) **Assessment of a single family residence solar heating system in a suburban development setting. Monthly report.** Phillips, J.D. (Colorado Springs Dept. of Public Utilities, Colo. (USA)). 10 Nov 1975. 18p. (Phoenix—017). NTIS $3.50.

Prepared for Phoenix of Colorado Spring, Inc., Colo.

This report presents the monthly accumulation of data for the operation of the solar optimized heat pump heating system in the Phoenix house. An additional heat exchanger was installed, and a test was conducted to see if enough heat could be given up to the return air plenum of the heat pump to sufficiently heat the house.

41214 (PB—254495) **Assessment of a single family residence solar heating system in a suburban development setting. Monthly report.** Phillips, J.D. (Colorado Springs Dept. of Public Utilities, Colo. (USA)). 10 Oct 1975. 19p. (Phoenix—016). NTIS $3.50.

See also PB—242727. Prepared for Phoenix of Colorado Springs, Inc., Colo.

The operational status of the solar optimized heat pump in the Phoenix house is discussed. The following appendices and tables are included: (1) Phoenix Power Consumption and Flow Rates; (2) Solarimeter Calibration, Energy Collected and Evaporator Coil Heat Transfer; (3) Computer Analyzed Data; (4) Data Acquisition and Analysis System; (5) Assumptions for Program; (6) Solar Heat Collectors Balance Test; (7) Ground Water Flow Study.

41215 (PB—254502) **Assessment of a single family residence solar heating system in a suburban development setting. Monthly report.** Phillips, J.D. (Colorado Springs Dept. of Public Utilities, Colo. (USA)). 10 Dec 1975. 22p. (Phoenix—018). NTIS $3.50.

Prepared for Phoenix of Colorado Springs, Inc., Colo.

The report assesses the performance of a single family residence solar heating system in a suburban development. Data are presented on the operation of the solar heating system.

41216 (PB—255049) **Assessment of a single family residence solar heating system in a suburban development setting. Monthly report, 10 Aug—10 Sep 1975.** Phillips, J.D. (Colorado Springs Dept. of Public Utilities, Colo. (USA)). 10 Sep 1975. 32p. (Phoenix—015). NTIS $4.00.

Prepared for Phoenix of Colorado Springs, Inc., Colo. See also PB—246141.

The report describes a variation to Mode C (experimental mode of operation) which used Dowtherm J in a closed loop system from the water storage tank for transfer of heat energy to the outdoor intake air plenum on the evaporator side of the heat pump by means of an economizer coil. Modifications using a liquid to Freon heat pump were made on all subsystems of the Phoenix house. Changes, problems encountered and solutions are discussed in the following order: solar collections; heat transfer fluid; piping system; heat pump; outside air duct system; control system; and data analysis system. Portions of this document are not fully legible.

41217 (PB—255928) **Solar energy applications in agriculture: potential, research needs, and adoption strategies, summary and recommendations.** Bender, F.E.; Cowan, A.M.; Dillon, R.W. (Maryland Univ., College Park (USA). Agricultural Experiment Station). Jan 1976. 39p. (Bull-A—185). NTIS $4.00.

Sponsored in part by Agricultural Research Service, Washington, D.C.

This report briefly discusses solar applications in: corn and rice grain drying; curing of tobacco and peanuts; heating of animal shelters; heating of greenhouses and rural, especially on-farm, residences; and, irrigation.

41218 **Method and equipment to collect and store solar energy.** Keyes, J.H.; Strickland, R.G.; Strickland, C.I. (to International Solarthermics Corp.). German(FRG) Patent 2,507,570/A/. 28 Aug 1975. 51p. (In German).

25 figs.

As usual, the flat plate collector consists of a blackened absorber plate covered by a transparent glass plate. The collector is mounted directly on a heat accumulator. The framework of the heat accumulator is triangular and accomodates the heat collector on one side. The accumulator material is gravel. The heat taken up by the collector is transported by means of an air flow generated by pumps. The heat accumulator is coupled to a space heating installation. Here, too, heat is transported by an air flow.

41219 **Houses in Linkoping heated with solar energy.** *VVS - Tidskr. Varme, Vent., Sanit.;* **47**: No. 8, 30-32, 50(Aug 1976). (In Swedish).

The solar heating system of an experimental one-family house constructed five years ago is briefly described and the experience with the systems operation acquired so far is outlined.

41220 **Termoroc house in Limhamn.** *VVS - Tidskr. Varme, Vent., Sanit.;* **47**: No. 8, 33-35(Aug 1976). (In Swedish).

The article describes briefly the design of a new experimental one-family house constructed in 1975 and equipped with the second-generation solar heating system. The heretofore acquired experience with the heating system is reviewed.

41221 **Zero-energy house in Lyngby.** Esbensen, T.V. (Dan Tek Hogsk, Den). *VVS - Tidskr. Varme, Vent., Sanit.;* **47**: No. 8, 37-39(Aug 1976). (In Swedish).

The article describes briefly the experience acquired with the operation of a solar heating system incorporated in an experimental one-family house constructed in 1975 in Denmark.

41222 **Low-energy house in Vetlanda.** *VVS - Tidskr. Varme, Vent., Sanit.;* **47**: No. 8, 41-44(Aug 1976). (In Swedish).

The features of a recently constructed one-family house characterized with a low energy construction and equipped with the so-called passive solar heating system are briefly described. The calculated thermal energy balance is tabulated and plotted graphically.

41223 **Simulation and operation of a solar powered organic Rankine cycle turbine.** Veneruso, A.F. (Sandia Lab, Albuquerque, NM). *Am. Soc. Mech. Eng., [Pap.]*: No. 76-WA/Sol-18, 1-15(5 Dec 1976).

Sandia Laboratories' ERDA-sponsored Solar Energy System Test Facility utilizes 814 m^2 (8759 ft^2) of solar tracking, east-west oriented, parabolic trough collectors to heat Therminol 66 heat transfer fluid to 316 C (600 F). The energy is stored as sensible heat in a 4246-gal storage tank. The solar-heated fluid is then used to power an organic Rankine cycle turbine supplied by Sundstrand Aviation of Rockford, Illinois. This turbine supplies 32 kW of electricity as well as providing, through its condenser output loop, space heating and cooling with an absorption air conditioner. This test system with programmable inputs and loads, comprises a flexible experimental tool for evaluating components and subsystems. The simulation procedure consists of mathematically modeling the turbine components, heat exchangers, solar-heated fluid loops, and controls.

DRYING AND CURING

REFER ALSO TO CITATION(S) 41217

HEAT ENGINES

REFER ALSO TO CITATION(S) 41223

41224 (SAND—76-0358) **Solar powered irrigation system. Quarterly progress report to ERDA/DSE.** Alvis, R.L.; Alcone, J.M. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1976. Contract E(21-1)-789. 113p. Dep. NTIS, PC A06/MF A01.

The activities of the Solar Powered Irrigation System project have been organized and the participants are working on the project. The demonstration system has been sized, component specifications written, and the collector system purchased. The cost of the collectors was lower than estimated. This, combined with the selected site well characteristics, allowed system performance to be increased to approximately 800 gallons per minute of water pumped and the pump will run for approximately 24 hours per day. The project activities permit separation of the water pumping from the agricultural experiments and allows the most efficient use of each. Sandia Laboratories is responsible for the pumping of the water and New Mexico State University is responsible for the water-application as part of the agricultural experiments.

SOLAR COLLECTORS AND CONCENTRATORS

REFER ALSO TO CITATION(S) 41179, 41223

41225 (N—76-27433) **Method for measuring the solar absorption factor.** Simon, J. (Centre National d'Etudes Spatiales, 31 - Toulouse (France)). Mar 1976. 18p. (CNES-NT—34). NTIS, PC A03/MF A01.

A method for measuring the thermal control coatings solar absorptance is discussed. Solar absorptance is determined at room temperature by near normal absolute spectral reflectance measurements over the wavelength region of 0.2 to 2.7 m. The resulting spectral data is then integrated against the Thekaekara curve to obtain solar reflectance from which the solar absorptance is inferred.

41226 (N—76-28404) **Improvement of black nickel coatings. Final report.** Peterson, R.E.; Lin, J.H. (Honeywell, Inc., Minneapolis, Minn. (USA). Systems and Research Center). Jun 1976. Contract NAS8-31545. 62p. (NASA-CR—149928). NTIS $4.50.

Selectively absorbing black nickel coatings are among the most optically efficient low cost coatings for use on flat plate solar collectors. However, a current Ni-Zn-S-O coating in use is quite susceptible to a humid environment, degrading badly in less than ten days at 38 C (100 F) at 95 percent relative humidity. Therefore, a black nickel formula was developed which can withstand such exposures with no loss of optical efficiency, solar absorption of 0.92 and an infrared emittance (at 100 C) of 1.00 were still present after 14 days of humidity exposure. This compares to a solar absorptance of only 0.72 for the previous formula after a similar time period. The electroplating bath and conditions were changed to obtain the more stable coating configuration. The effect of bath composition, temperature, pH, and plating current density and time on the coating composition, spectral optical properties and durability were investigated systematically.

41227 (N—76-28649) **The transient thermal response of a tubular solar collector.** Lansing, F.L. (Jet Propulsion Lab., Pasadena, Calif. (USA)). 15 Jul 1976. Contract NAS7-100. 44p. (NASA-CR—148488;JPL-TM—33-781). NTIS $4.00.

A special analytical solution is provided for the timewise response of the circulating fluid temperatures when a sudden step change of the input solar radiation is imposed and remains constant thereafter. An example which demonstrates the transient temperatures at the exit section of a single collector with two different flow patterns is presented. This study is used to supplement some numerical solutions to provide a fairly complete coverage for this type of solar collector.

41228 (PB—261850) **Cadmium stannate selective optical films for solar energy applications. Final report, 1 Jul 1973—31 Aug 1976.** Haacke, G.; Burton, L.C. (American Cyanamid Co., Stamford, Conn. Chemical Research Div.). Sep 1976. 70p. NTIS, PC A04/MF A01.

Prepared in cooperation with Delaware Univ., Newark. Inst. of Energy Conversion. See also PB—253007.

The development of cadmium stannate coatings for utilization in solar energy converters is reviewed. Significant results achieved during the course of the program are as follows: (1) Transparent Cd_2SnO_4 films with 1 ohm/square sheet resistance and 85-90% transmission over parts of the visible spectrum can be prepared by RF sputtering; (2) $CdSnO_3$ is also a transparent conductor and films with 10-20 ohm/square and 75-85% transmission between 5500-7500 A have been produced by spray coating; (3) The potential of Cd_2SnO_4 films for high-temperature greenhouse window coatings and as components in selective absorbers has been evaluated; (4) Backwall Cd_2SnO_4/CdS/Cu/sub x/S solar cells with about 6% conversion efficiency (AMI sunlight) were fabricated.

41229 **Performance measurements of a cylindrical glass honeycomb solar collector compared with predictions.** McMurrin, J.C.; Djordjevic, N.A.; Buchberg, H. (Univ of Calif, Los Angeles). *Am. Soc. Mech. Eng., [Pap.];* No. 76-Wa/Sol-3, 1-9(5 Dec 1976).

A glass tube honeycomb solar collector, composed of a conventional single-glazed flat-plate, water-cooled, nonselective black absorber with a cylindrical glass honeycomb mounted between the plate and cover glass was designed, fabricated, and tested. The test procedure followed the National Bureau of Standards Method of Testing for Rating Solar Collectors. The honeycomb consists of individual cylindrical thin-wall glass tubes standing on end on the absorber plate in a hexagonal close-packed pattern. The tubes are 9.5 mm I.D., 0.2-mm wall thickness, 5.3 length to diameter ratio made of glass with mean solar absorptive index, $2.6 \times 10^{-6}\ \mu m^{-1}$, evaluated from spectral transmittance-reflectance measurements on a tubing specimen. The collector performance equaled or surpassed theoretical predictions for measurements made over a broad range of collector inlet temperatures (43 to 116 C) and environmental conditions.

41230 **Temperature distribution along an absorbing-emitting fluid layer flowing over an opaque substrate.** Abrams, M. (Sandia Lab, Livermore, Calif). *Am. Soc. Mech. Eng., [Pap.];* No. 76-WA/Sol-5, 1-16(5 Dec 1976).

In order to determine the thermal behavior of the molten salt solar cavity, a theoretical model has been developed which predicts the temperature distributions along the molten layer and along the underlying substrate in the direction of flow. This model has been employed to assess the effects of altering the molten salt flow rate, optical thickness, reflectance of the substrate, and the film conductance between the substrate and molten layer. One of the findings of this study is that opacifying the molten layer (by the introduction of a suspension of radiation-absorbing particles, for example) significantly reduces the temperature level of the substrate while it simultaneously increases that of the fluid.

41231 **Development of compound parabolic concentrators for solar thermal applications.** Allen, J.; Levitz, N.; Rabl, A.; Reed, K.; Schertz, W.; Winston, R. (Argonne Natl Lab, Ill). *Am. Soc. Mech. Eng., [Pap.];* No. 76-WA/Sol-11, 1-8(5 Dec 1976).

The compound parabolic concentrator (CPC) is a nonfocusing concentrator which achieves maximal concentration with minimal tracking requirements. It allows, for example, concentration values up to 10 without any diurnal tracking. The potential applications of the CPC cover space heating and cooling, process heat, solar thermal conversion and photovoltaic power generation. Several CPC collectors for high temperature (up to 200 C) operation have been designed and constructed. A variety of different configurations, materials and fabrication techniques have been tried to determine the best possible design for a given application. The performance with nonselective and with selective (black chrome) absorber coatings is compared. One of the collectors uses an absorber inside an evacuated glass tube. The test procedures are described and preliminary results are presented. 5 refs.

HEAT STORAGE AND REJECTION

41232 (AD-A—029155) **Compilation of solar data for White Sands Missile Range.** Taft, P.H.; McCullough, D.G. (Army Electronics Command, White Sands Missile Range, N.Mex. (USA). Atmospheric Sciences Lab.). May 1976. 26p. (DR—916). NTIS, PC A03/MF A01.

Tables and graphs are presented, with explanatory text, giving times of sunrise and sunset, duration of daylight, twilight and darkness, solar altitudes and azimuths, the Earth's shadow height, and related data frequently used at White Sands Missile Range. Because of increased interest in solar energy, a new section called solar radiation intensities has been included.

41233 (N—76-28738) **Solar microclimatology. Final report.** Mckenney, D.B.; Beauchamp, W.T. (Helio Associates, Inc., Tucson, Ariz. (USA)). Nov 1975. Contract NASW-2745. 71p. (NASA-CR—148533). NTIS $4.50.

It has become apparent in recent years that solar energy can be used for electric power production by several methods. Because of the diffuse nature of the solar insolation, the area involved in any central power plant design can encompass several square miles. A detailed design of these large area collection systems will require precise knowledge of the local solar insolation. Detailed information will also be needed concerning the temporal nature of the insolation

and the local spatial distribution. Therefore, insolation data was collected and analyzed for a network of sensors distributed over an area of several square kilometers in Arizona. The analyses of this data yielded probability distributions of cloud size, velocity, and direction of motion which were compared with data obtained from the National Weather Service. Microclimatological analyses were also performed for suitable modeling parameters pertinent to large scale electric power plant design. Instrumentation used to collect the data is described.

GEOTHERMAL ENERGY

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

GEOPHYSICAL TECHNIQUES AND SURVEYS

REFER ALSO TO CITATION(S) 41236

41234 (AD-B—006305) **Geothermal energy in the pacific region. Appendix A: exploration for a geothermal system in the Lualualei Valley, Oahu, Hawaii. Appendix B: exploration on Adak Island, Alaska.** Grose, L.T.; Keller, G.V.; Tasci, M.T.; Butler, D.L. (Colorado School of Mines, Golden (USA)). May 1975. Contract N00014-71-A-0430-0004. 84p. NTIS $5.00.

Appendices A and B to AD-B—006304.

No abstract available. (GRA)

41235 (PB—258100) **Deep electrical resistivity investigations coupled with dry geothermal reservoir experiments in New Mexico. Technical progress report.** Jiracek, G.R. (New Mexico Univ., Albuquerque (USA). Dept. of Geology). Mar 1975. 52p. NTIS, PC A04/MF A01.

Deep electrical resistivity investigations are conducted in the Jemez Mountains of New Mexico in conjunction with the hot dry-rock geothermal test wells drilled by Los Alamos Scientific Laboratory. These studies use a 50 kw constant-current transmitting system. The resistivity measurements and theoretical model studies emphasize the complexity of the region surrounding the LASL drillholes. One pronounced lateral resistivity variation east of the drill site is probably due to the western ring-fracture boundary of the Valles Caldera. The ring-fracture system may be acting as a deep, hot water plumbing system which is responsible for an electrically conductive anomaly, the hot-spring activity of the region, and the successful geothermal wells drilled nearby by Union Oil Company. Proposed continued resistivity studies in the Jemez Mountains are designed to attempt the electrical detection of deep fractures using a combined surface-downhole technique. It is recommended that future hot dry-rock geothermal site selections be based on prior resistivity studies coupled with thermal gradient or heat flow measurements.

EXPLORATORY DRILLING AND WELL LOGGING

41236 (PB—262643) **On shallow-hole temperature measurements--a test study in the Salton Sea geothermal field.** Lee, T. (California Univ., Riverside (USA). Inst. of Geophysics and Planetary Physics). 1976. 40p. (IGPP-UCR—76-6). NTIS, PC A03/MF A01.

Shallow-hole (<13 m) temperature measurements made at various depths and/or times may yield reliable values of geothermal gradient and thermal diffusivity if the groundwater table is shallow enough that the effect of time-dependent moisture content and physical properties is negligible. Two numerical methods based on non-linear least-squares curve fitting are derived to remove the effect of annual temperature wave at the ground surface. One method gives the gradient and diffusivity as a function of depth while the other gives the weighted average values. Experiments were carried out in six test holes cased with 2 cm O.D. pvc pipes in the Salton Sea geothermal field.

ECONOMIC AND FINANCIAL ASPECTS

41237 **Investigation of the technical and economical feasibility of using low temperature geothermal sources in Colorado.** Nannen, L.W.; Kreith, F.; West, R.E. (Environ Consult Serv, Inc, Boulder, Oreg). *Energy (Oxford);* **1**: No. 2, 179-216(Jun 1976).

A preliminary feasibility study of utilizing low temperature geothermal sources in Colorado to heat buildings has been completed. It is concluded that the technology for using geothermal sources to heat buildings exists and that the cost of heat will be between $2 and $5 per million Btu delivered. Although geothermal heating is more expensive than heating with natural gas at current prices, it is considerably less expensive than heating by means of current solar thermal conversion methods. It is, therefore, recommended that an exploratory well be drilled in a place such as Glenwood Springs, Colorado, to define the thermal, chemical, and geological characteristics of a geothermal source in detail as a first step toward utilization of geothermal energy on a commercial scale in Colorado. 31 refs.

ENVIRONMENTAL ASPECTS AND WASTE DISPOSAL

REFER ALSO TO CITATION(S) 42115

GEOTHERMAL POWER PLANTS

POWER PLANT SYSTEMS AND COMPONENTS

41238 **Direct contact heat exhangers in geothermal power production.** Sheinbaum, I. (Ben Holt Co, Pasadena, Calif). *Am. Soc. Mech. Eng., [Pap.];* No. 75-HT-52, vp(1975).

The direct contact cycle can be advantageously utilized in the production of power from liquid dominated geothermal resources. The heat from the geothermal resource is transferred to a selected working fluid by direct countercurrent contact in a vertical perforated trayed tower. The direct contactor is divided into three heat transfer zones where heat is extracted from the hot water by liquid-liquid contact, mixed phase boiling and vapor liquid contact. A procedure is presented for optimizing the cycle, sizing the direct contactor and evaluating the number of cross temperature contacts and tray efficiencies in each of the heat transfer zones. the relationship between heat transfer and mass transfer is indicated for the perforated trayed tower. 21 refs.

GEOTHERMAL ENGINEERING

DRILLING TECHNOLOGY AND WELL HARDWARE

41239 **Design of an insulated coaxial pipe assembly for a drilled geothermal wall.** Warren, J.H.; Whitelaw, R.L. (Va Polytech Inst and State Univ, Blacksburg). *Am. Soc. Mech. Eng., [Pap.];* No. 75-HT-56, vp(1975).

The design of an insulated coaxial pipe assembly for a 50,000 ft (15.24 km) drilled geothermal well is given. The design permits the removal of heat from the earth's crust by the circulation of water through a single well. the design problems are compounded by the presence of a hot and cold fluid in counterflow, large differential thermal expansion between the liners of the coaxial pipe assembly, large hydrostatic pressures resulting from the depth of the well, and a feasible means of insulating, supporting and installing the ten-mile long coaxial pipe assembly. The paper gives a conceptual solution with oil being used as the insulating material between the hot and cold water. 10 refs.

CORROSION, SCALING, AND MATERIALS DEVELOPMENT

41240 (PB—254990) **Materials problems associated with the development of geothermal energy resources.** Hall, B.A. (Geothermal Resources Council, Davis, Calif. (USA)). May 1975. 46p. NTIS, PC A03/MF A01.

A preliminary workshop-meeting was held to discuss various materials problems associated with the development of geothermal resources. Representatives of the geothermal user industry, the corrosion and scaling research laboratories, and the metals industry discussed past efforts and to prepare preliminary outlines of areas where research is required. The problems associated with the development of the geothermal brines of the Imperial Valley, Calif., were the primary subjects of discussion. The corrosion and scaling of materials and equipment is a major problem and the development of resistant materials and specialized equipment were discussed. Chemistries of and laboratory gas solubilities in brines were presented. (GRA)

DIRECT ENERGY UTILIZATION

REFER ALSO TO CITATION(S) 41237

GEOTHERMAL DATA AND THEORY

PROPERTIES OF AQUEOUS SOLUTIONS

REFER ALSO TO CITATION(S) 41877

PROPERTIES OF MINERALS AND ROCKS

41241 (PB—258098) **Geology and geochemistry of the Dunes Hydrothermal System, Imperial Valley of California.** Bird, D.K. (California Univ., Riverside (USA). Inst. of Geophysics and Planetary Physics). Mar 1975. Contract NSF-AER72-03551. 135p. (IGPP-UCR—75-2). NTIS, PC A07/MF A01.

The Dunes hydrothermal system is located near the southeast basin margin of the Salton Trough structural rift in southern California. Intense potassium and silica metasomatism is associated with hydrothermal alteration of lateral clastic aquifers in the discharge portion of this hydrothermal system. The rocks recovered are terrigenous detritus of the Colorado River delta, and consist primarily of sands with highly uniform mineralogical composition. Four distinct sedimentary facies are present, including deltaic sand, channel fill, braided stream-dune, and lacustrine facies. Diagenetic alteration has produced poorly indurated sediments cemented by varying amounts of hematite, calcite, gypsum, and montmorillonoid clays. Potassium silicate hydrothermal alteration, characterized by authigenic quartz, adularia, pyrite, and hydromuscovite, has occurred within seven intervals (5 to 35 meters thick) of permeable strata of the channel fill and braided stream-dune facies. The resultant rocks are dense, vitreous, sublithic quartzites with densities as high as 2.55 gm/cc and porosities as low as 3-4%. Hydrothermally altered sands have a net chemical gain of SiO_2 and K2O, and loss of CaO, Na_2O, FeO, and MgO, in comparison with unaltered surface sands. (GRA)

ROCK-WATER-GAS INTERACTIONS

REFER ALSO TO CITATION(S) 41241

TIDAL POWER

WAVE ENERGY CONVERTERS

41242 **Wave power nodding duck wave energy extractors.** Salter, S.H.; Jeffrey, D.C.; Taylor, J.R.M. (Univ of Edinburgh, Scotl). *Energy Dig. (London)*; **5**: No. 4, 19-21(Aug 1976).

Stating that North Atlantic waves on a 500 kilometer front could produce all the electricity now used in the United Kingdom, the authors describe an offshore mechanism proposed for generating electric energy by utilizing motion imparted by seawater waves. It consists of a number of 'duck'-shaped segments rotating about a common backbone. The whole structure has a very low freeboard so that it could be easily submerged. The rear surface of each duck is a cylinder coaxial with the center of rotation so that no water is displaced behind and no rear wave created. The front curve is designed to match the displacements of water in approaching waves. The natural 'nodding' period is designed to coincide with the wave period where maximum efficiency is required and attempts are made to broaden the frequency response. Each duck runs on rollers which are the bodies of commercially available rotary hydraulic pumps. High pressure oil drives hydraulic swash plate motors coupled to electrical generators at sea. Each meter length of structure displaces just over one hundred tons. One string of ducks will be about 500 meters long.

WIND ENERGY

AVAILABILITY (CLIMATOLOGY)

41243 (RLO/2229/T12—76/1) **Wind power potential of Alaska. Part II. Wind duration curve fits and output power estimates for typical windmills.** Wentink, T. Jr. (Alaska Univ., Fairbanks (USA). Geophysical Inst.). Aug 1976. Contract E-76-S-06-2229. 92p. (UAG-R—240). Dep. NTIS $5.00.

An empirical analytical function (F1) and the Weibull function (F3) were compared for use in casting measured long-term wind speed frequency data in the form of the wind speed duration curves. Data from 18 Alaskan locations were used in the 248 cases treated. The fitted duration curves were coupled with the instantaneous power vs. wind speed characteristics for three wind energy conversion systems (WECS) to predict the probable monthly and annual mean energy productivity and power levels of the WECS. The latter, as used here, were rated at 6 KW (Elektro), 15 KW (Grumman), and 100 KW (NASA-Mod 0). In the absence of reliable test data for average energy or average power (anti P) at known average wind speeds no choice between F1 and F3 is obvious, but statistical tests favor F1. Both seem equally useful for wind power estimation. The validity of use of the long-term average wind speed as a key parameter in wind work is demonstrated. The main text contains seven figures, 15 tables and 11 references. An appendix dealing with the effect of furling on anti P contains six additional figures and two references.

WIND ENERGY ENGINEERING

POWER CONVERSION SYSTEMS

41244 (N—76-30650) **Transient analysis of unbalanced short circuits of the ERDA—NASA 100-kW wind turbine alternator.** Hwang, H.H.; Gilbert, L.J. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Jul 1976. 29p. (NASA-TM-X—73459;E—8821). NTIS $4.00.

Unbalanced short-circuit faults on the alternator of the ERDA-NASA Mod-O 100-kW experimental wind turbine are studied. For each case, complete solutions for armature, field, and damper-circuit currents; short-circuit torque; and open-phase voltage are derived directly by a mathematical analysis. Formulated results are tabulated. For the Mod-O wind turbine alternator, numerical calculations are given, and results are presented by graphs. Comparisons for significant points among the more important cases are summarized. For these cases the transients are found to be potentially severe. The effect of the alternator neutral-to-ground impedance is evaluated.

SITE CHARACTERISTICS

41245 (ERDA/NSF/00702—75/1) **Sites for wind power installations: wind tunnel simulation of the influence of two-dimensional ridges on wind speed and turbulence. Annual report, first year.** Meroney, R.N.; Sandborn, V.A.; Bouwmeester, R.J.B.; Rider, M.A. (Colorado State Univ., Fort Collins (USA). Dept. of Civil Engineering). Jul 1976. Contract NSF-RANN-GAER-75-00702. 88p. Dep. NTIS $5.00.

The objective of this research was to increase technical capacity to locate favorable wind system sites, reduce uncertainty in the prediction or validation of the characteristics of sites, and thus assist in the sizing and performance prediction of wind systems. The research included evaluation of low speed aerodynamics over terrain and boundary flow conditions over ridges by means of wind tunnel modeling. Measurements have been completed over triangular and sinusoidal shape hills of wind speed, static pressure variation, turbulence intensity, wall shear, and wind deflection. Hill aspect ratios studied range from $1/2$ to $1/6$ with some data available at $1/20$. Measurements of wind overspeed, streamline patterns, and turbulence changes over the topography are compared with results from boundary layer theory. Large overspeed effects over the hills are found for the shear layers investigated.

ELECTRIC POWER ENGINEERING

POWER PLANTS AND POWER GENERATION

REFER ALSO TO CITATION(S) 41563

41246 (PB—254297) **Minutes of and commentary on conference on utility load management held in Brussels on November 12—13, 1974 under the auspices of the NATO Committee on challenges of modern society.** (Gordian Associates, Inc., New York (USA)). Dec 1974. 350p. NTIS $10.00.

The purpose of the Brussels conference was to bring the representatives of the U.S. and European utilities together across a table to resolve issues raised at previous meetings and to delve more deeply into the possibilities of load leveling on the utility side of the meter and by industrial consumers of electric energy. Among the issues raised at previous meetings were the necessity of resolution of differences concerning rate structure rationale, further insight into the economics of time of day/peak load metering, and the economics of European storage heating systems. In addition, representatives of the European utilities had expressed interest in learning about United States experience with air conditioning and electric heating.

41247 (PB—255659) **Study of inplant electric power generation in the chemical, petroleum refining, and paper and pulp industries. Final report.** Nydick, S.E.; Davis, J.P.; Dunlay, J.; Fain, S.; Sukhuja, R. (Thermo Electron Corp., Waltham, Mass. (USA)). Jun 1976. Contract FEA-CO-04-50224-00. 314p. (TE—5429-97-76). NTIS $9.75.

See also PB—255658.

The maximum thermodynamic and economic potentials for increased inplant electric power generation by steam turbine, gas turbine, and diesel topping and steam and organic bottoming cycles

are determined for the chemical, petroleum refining, and paper and pulp industries with and without government sponsored economic incentives. Institutional, legal and regulatory constraints were also assessed.

41248 (PB—258264) **Existing and proposed fuel conversion facilities. Summary.** (Environmental Protection Agency, Denver, Colo. (USA). Region VIII). Jul 1976. 37p. (EPA—R8-TS-5). NTIS $4.00.

This report provides a summary of existing and proposed coal conversion facilities in addition to hydroelectric plants on a state-by-state basis for the six states (Colorado, Montana, North Dakota, South Dakota, Utah and Wyoming) of EPA Region VIII. It identifies the location, facility name, number of units, operating company and other participants, plant capacity, and the fuel type for the various conversion facilities. (GRA)

41249 Systematic design strategies and process diagnostics for power plants. Altmann, W.; Schilg, G.; Thor, G.; Vetter, O. (Tech Univ, Dresden, E Ger). *Energietechnik;* **25**: No. 4, 154-159(Apr 1975). (In German).

The creation of suitable information storage facilities to serve as a design aid is considered. It is shown how considerable economic losses can be avoided if better information sources are available to the designers and plant operators. The effect of the rate of load changes on the construction of turbomachinery is discussed, along with the complication analysis for a steam generating component in order to show how to go about with the systematic evaluation of experiences.

41250 Thermoelectric power plants: a rational way of energy utilization in Europe. Winkens, H.P. *Gas, Wasser, Waerme;* **29**: No. 6, 183-189(Jun 1975). (In German).

Comparative study of various energy sources, production methods, and losses. Diagrams and curves show calculations.

41251 Osmosis process for producing energy. Jellinek, H.H. US Patent 3,978,344. 31 Aug 1976. Priority date 12 Nov 1973, Japan. 8p.

A process is described for generating energy by utilizing the osmotic pressure resulting when two liquids having different chemical potentials are each placed in contact with opposite sides of the same semipermeable membrane. The process is particularly applicable to the production of energy from the system sea water/fresh water. The sea water is in the form of an enclosed body having an outlet orifice in communication therewith. The fresh water passes through the semipermeable membrane causing the osmotic pressure which ejects a stream of salt water through the outlet orifice.

COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS

REFER ALSO TO CITATION(S) 41498

41252 Natural-draft cooling tower of the so-called dry type. Heeren, H. (to Maschinenfabrik Augsburg-Nuernberg (M.A.N.) A.G.). German(FRG) Patent 2,454,455/A/. 20 May 1976. 7p. (In German).

2 figs.

The invention is concerned with a natural-draft cooling tower of the dry type. The upper part, which is free of internals, has a circular or polygonal cross-section with at least 16 angles; in the lower part, with square cross-section, horizontal groups of heat exchanging elements are arranged which totally cover the cross-sectional area. The upper and the lower part of the cooling tower are joined by a flow-optimized intermediate part. Because of the square-shaped cross-section, the sealing plates required for round cooling towers are avoided and the existing flow cross-section is fully utilized.

41253 (N—76-30612) **Minimum weight design of cooling towers.** To, J.K.W.; Hemp, W.S. (Oxford Univ. (UK). Dept. of Engineering Science). 1975. 19p. (OUEL—1138/75). NTIS, PC A02/MF A01.

The minimum weight design of cooling towers designed to withstand wind differential pressure of maximum value coming from winds with any compass bearings is considered on the basis of the following assumptions: (1) the tower is a shell of revolution made from a homogeneous material of thickness depending on a vertical coordinate z, with an allowable stress in tension and compression, (2)the ratio of the radius z sub zero at the top of the tower to the tower height h is prescribed, (3) the slope of the diverging part of the tower, as measured from the vertical, is restricted so as not to exceed the ratio 1/8, which is necessary to ensure the efficient functioning of the tower as a chimney, and (4) the strength of the tower is determined by the membrane stresses induced by wind pressures, etc. Results of the analysis are presented in graphical form and give the ratio of the base radius to the height as a function of r sub 0/h, V/p cu h, as a function of r sub 0/h, and the profile and thickness distributions for r sub 0/h = 0.1, 0.3, 0.5, 0.7, and 0.9.

41254 (PB—254401) **Selected aspects of waste heat management. Summary report.** Serper, A. (Equitable Environmental Health, Inc., Woodbury, N.Y. (USA)). Jun 1976. 56p. NTIS $4.50.

The study reviews the state-of-the-art in: (1) treatment of evaporative cooling systems and offstream cooling system effluents; (2) additional treatment required to utilize wastewater from sewage treatment plants as makeup for cooling systems and boilers; (3) mathematical modeling for power plants cooling systems and discharges; (4) current and recent field monitoring programs; (5) present research to reduce the capital cost and penalties associated with dry cooling towers; and (6) areas where future research is needed.

41255 Steam cooler plant for steam released for technological purposes. Egorov, V.E. (Kurskenergo, USSR). *Teploenergetika (Moscow);* No. 6, 60-62(Jun 1975). (In Russian).

The problem of thermal efficiency of having a steam cooler for steam tapped for technological purposes included in the circuit of an industrial and heating power plant is considered. A rough estimate of the cost recovery period of such steam coolers is given.

41256 Performance of an evaporative cooler. Tezuka, S. (Tokyo Univ. of Mercantile Marine); Kasai, S.; Nakamura, T. *Heat Transfer - Jpn. Res.;* **6**: No. 1, 1-18(1977).

Experimental results on performance of evaporative coolers are reported. The data are correlated by means of nondimensional equations. The volumetric mass transfer rate Ka was found to be a function of the equivalent diameter: Ka varies as $de^{-0.3}$.

POWER CYCLES

REFER ALSO TO CITATION(S) 40731, 40773

41257 Mastering the steam-and-gas 200 MW power unit and prospects of application of high-capacity steam-and-gas plants in power generation. Markov, N.M.; Prutkovskii, E.N.; Demirchyan, Kh.G.; Bachilo, L.L.; Fedosyuk, A.F.; Krokhin, V.A. (Cent Boiler and Turbine Inst, USSR). *Teploenergetika (Moscow);* No. 6, 27-30(Jun 1975). (In Russian).

The power unit built at the Nevinnomysskaya GRES in 1972 comprises a steam turbine with the capacity of 160MW, a gas turbine unit with an additional combustion chamber and a high-pressure steam generator. The useful electric capacity of the gas turbine unit amounts to 32.2MW. The high-pressure steam generator is small-sized. The experience of operation of the steam-and-gas power unit shows that its design is correct. Such units are suitable for areas supplied with gas and low-ash content liquid fuel.

41258 Some features of organization of starting conditions of the 300 MW monoblock. Plotkin, E.R.; Krol', A.Ya.; Goverdovskii, E.E.; Izrailev, Yu.L.; Kremenchugskii, V.M. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 6, 39-46(Jun 1975). (In Russian).

Results are presented of an investigation of starting regimes, carried out on a 300 MW monoblock of the Kostromskaya power plant with a steam generator and a turbine, aiming to appraise the capacities of the equipment and the starting scheme of the monoblock, and to work out the technology of starting from different thermal conditions. Steam and metal temperature measurements were taken. The results show that preliminary heating of the system of intermediate superheating is not indispensable when starting from the uncooled state. Graphs of starting conditions of the block are worked out taking into account the dependence of the strength and thermophysical properties of steel on temperature.

WASTE-FUELED SYSTEMS

REFER ALSO TO CITATION(S) 41174

41259 (PB—253326) **Markets and technology for recovering energy from solid waste.** (Environmental Protection Agency, Washington, D.C. (USA). Office of Solid Waste Management Program). 1974. 37p. (EPA—530/SW-130). NTIS $4.00.

A review is given of the characteristics of the major energy products recoverable from solid waste, the marketability of these products, the potential markets, and the status of the technology for recovery. The first section considers the fuels--solid, liquid, and gaseous--that can be created out of solid waste. The second section examines steam and electricity, two other forms in which the energy from solid waste can be sold. In the final section, the various systems and energy products are compared.

41260 Power from urban refuse. Marshall, J.E. (Imp Met Ind (Kynoch) Ltd, Birmingham, Engl). *Electr. Eng. (Melbourne);* **53**: No. 5, 25-26(May 1976).

At a large factory in Birmingham in the English midlands, all power requirements are met by the plant's own power station, and in 1972 the company began to study the idea of using domestic refuse as a boiler fuel. By the end of 1973 there was a scheme to fire

domestic refuse into three of the boilers. Details are presented about the method used, economic factors as well as future aspects.

COMPONENTS

REFER ALSO TO CITATION(S) 40732, 41559, 41560

41261 Thermodynamic cycles and elemental efficiencies. Naylor, V.D. *Arch. Budowy Masz.;* **21**: No. 4, 471-479(1974).

The subject of consideration is a 'real' Joule's thermodynamic cycle with m-fold interstage cooling and n-fold interstage heating. Interstage losses are taken into account. By letting m and n tend to a limit, a 'hexagonal' cycle is obtained which is optimum and comprises as particular cases the cycles of Carnot, Joule and Ericsson. It is found that in the 'real' case (that is, if the losses are taken into consideration), the 'hexagonal' cycle may be better than that of Carnot. The natural application of the 'hexagonal' cycle is to large gas turbines.

41262 Power plant tubing--a critical review. Eiden, H.; Vorwerk, K. (Tech Ueberwach-Ver Rheinland, Cologne, Ger). *Maschinenschaden;* **48**: No. 3, 69-76(1975). (In German).

Based on statistical and analytical investigations, the principal factors relevant to damage to power plant hot steam tubing are identified. Quantitative data and important parameters are given for a major power plant. Conclusions are drawn with respect to design, construction, and operation of power plant tubing.

41263 Energy supply problems of process control computers in power plants. Papp, G. (Villamosenergiaipari Kut Intez, Hung). *Meres Autom.;* **23**: No. 6, 209-215(1975). (In Hungarian).

An analysis of the possible solutions to the energy supply problems of process control computers with active and passive functions is described.

41264 Calculation of flame tube temperature of a multiregister combustion chamber, made by Nevskii Engineering Works, with a swirl mixer. Sudarev, A.V. *Energomashinostroenie;* No. 5, 15-17(May 1975). (In Russian).

A method is proposed for the calculation of local values of temperature of flame tubes. It is based on research into the radiant and convective heat exchange processes in combustion chambers with aerodynamic division of air routes of both the direct-flow and counterflow designs. Results are presented of a comparison of the experimental and calculated data on flame tube metal temperature in the combustion chambers of GTK-10 gas turbine plants fueled by natural gas.

41265 Comparative measurements on large steam turbines. Hennig, Th.; Braun, F. (Kraftwerk Kassel, Ger). *VGB Kraftwerkstech.;* **55**: No. 5, 308-314(May 1975). (In German).

Instrumentation and accuracy requirements in steam flow measurements are described and defined in view of new standards on 'Thermal Acceptance Tests on Steam Turbines'. Tables, diagrams, and graphs represent procedures and results.

41266 Graphs for determination of exhaust gases and radiation heat exchanger size in steam generators. Geisler, K.W. *Waerme;* **81**: No. 2, 24-28(Jun 1975). (In German).

An approximate determination of flue gases as a factor of different fuels is discussed. Diagrams and nomograms are given for various parameters.

41267 Prospects of development of gas turbine installations in the USSR. Siryi, P.O.; Polishchuk, V.L.; Kirillov, I.I.; Markov, N.M.; Korsov, Yu.G. (Cent Boiler and Turbine Inst, USSR). *Teploenergetika (Moscow);* No. 6, 2-4(Jun 1975). (In Russian).

In 1974 there were over 600 gas pipelines pumping units with gas turbine drive, with the total capacity of over 3.7 million KW in the USSR. Their unit capacity was from 4.2 to 10 MW. In future, unit capacities of 16 MW and 25 MW are to be installed. The demand for peak capacities of electric power in the North-West, Center and South of the European part of the USSR will be 6--8 million KW by 1980 and about 20 million KW by 1990. This will have to be covered mainly by gas turbine power plants with 100 MW and higher capacitites.

41268 Tests of the gas turbine plant gt-100-750-2 using liquid fuel. Bodrov, I.S.; Ol'khovskii, G.G.; Tumanovskii, A.G.; Krugov, V.B.; Boiko, E.A. (Cent Boiler and Turbine Inst, USSR). *Teploenergetika (Moscow);* No. 6, 15-20(Jun 1975). (In Russian).

Specific features of operation of the high-capacity gas power plant using liquid fuel are analyzed. Difficulties are considered which have appeared during the tests and which concern the operation of the combustion chambers in the starting and working regimes, the operation of the fuel system, fuel distribution during the starting of the gas turbine plant. The ways to overcome these difficulties are pointed out.

41269 Design of control systems for electric power systems. Matijevic, V. (Rade Koncar, Zagreb, Yugosl). *Mess.-Steuern-Regeln;* **18**: No. 6, 215-219(Jun 1975). (In German).

The use of digital electronic devices for control systems of power networks is discussed. The application of small process computers for automatic operation of control centers is demonstrated on an example.

41270 Thermal and temperature regimes of the experimental membrane waterwall of the PK-41 steam generator. Semenovker, I.E.; Gol'dberg, Yu.A.; Vikhrev, Yu.V.; Fedoseenko, A.V. (Cent Boiler and Turbine Inst, USSR). *Teploenergetika (Moscow);* No. 6, 46-49(Jun 1975). (In Russian).

Temperature fields of waterwall tubes and fins, heat transfer coefficients around the perimeter of the waterwall tube, and maximum heat fluxes obtained in the membrane waterwalls of the lower radiant section of a PK-41 supercritical-pressure steam generator, are presented. The steam generator was fired by residual fuel oil and gas at the Konakovskaya district heating and power plant.

41271 Application of the factorial experiment to the analysis of the effectiveness of control systems. Kondrashin, A.V.; Pushlo, V.N.; Svetlov, V.D.; Levoshchenko, A.A.; Kharlamov, V.V. (Ivanovsk Power Eng Inst, USSR). *Teploenergetika (Moscow);* No. 6, 56-59(Jun 1975). (In Russian).

The problem of evaluation of the effectiveness of automatic control systems in unsteady conditions of operation, in particular in power plants, is considered. It is shown that the use of a regression model of the quality of the system can serve as a basis for the calculation of the mathematical expectation of the quality index. Principal statements are illustrated by an example of the analysis of the effectiveness of a steam temperture automatic control system.

41272 Some specific features of the calculation of the reliability indices of peak gas turbine power plants. Saprykin, G.S.; Galushko, V.F.; Rodyushkin, G.K. (Saratov, Polytech Inst, USSR). *Teploenergetika (Moscow);* No. 6, 82-83(Jun 1975). (In Russian).

The effect of the cyclic character of operation, and of the probability of successful starting, on the reliability characteristics and readiness of peak gas turbine power plants is considered. It is shown that the reliability (probability of trouble-free operation) and readiness of peak plants, over the same calendar period of operation, is higher than that of gas turbine power plants working in a continuous regime.

WASTE HEAT UTILIZATION

41273 Method of utilizing the excess heat of an electricity generating plant. Cahn, R.P.; Nicholson, E.W. (to Exxon Research and Engineering Co.). German(FRG) Patent 2,555,897/A/. 1 Jul 1976. 31p. (In German).

4 figs.

Until now, nuclear power stations can only operate on basic load; but even with fossil-fired power stations it is difficult to adapt the steam generators to operation with changing loads. In contrast, steam turbines are very flexible with respect to load. The invention is concerned with storing thermal excess power on small thermal loading of the power station at atmospheric pressure and high temperature in a liquid heat storing medium with with low vapor pressure, and with using this medium on high loading of the station for auxiliary heating by heat exchange, the turbine steam thus being available exclusively for power generation and no steam needing to be bled for preheating the feed-water. At low loads, on the other hand, steam is bled from at least one turbine stage and fed to a heat exchanger heating the liquid storage medium. With high temperature reactors, two fluid media can be used, e.g., oil for the temperature range 40 to 315°C and liquid sodium or another molten inorganic compound for the temperature range 260 to 540°C.

ECONOMICS

REFER ALSO TO CITATION(S) 41278, 41440, 41649, 41652

41274 (PB—255967) The marginal cost and pricing of electricity: an applied approach. Cicchetti, C.J.; Gillen, W.J.; Smolensky, P. (Planning and Conservation Foundation, Sacramento, Calif. (USA)). Jun 1976. 410p. NTIS $11.00.

The purpose of the study is to provide a practical guide for the analysis of the marginal cost structure of electric utilities for the purpose of designing electricity tariffs. The intended audience consists of those who have a working familiarity with electric power systems and who desire a general, but less abstract, discussion of the marginal cost structure of electric power systems than has heretofore been available. The premise states that tariffs which reflect the principal variations in marginal costs are superior to those which do not. Section 1 is a generalized description of the approach to marginal cost, its determinants, sources of variation and calculation; Section 2 consists of three illustrative case studies in which this

methodology is applied; Section 3 is a computer algorithm with a User's Guide for the computation of marginal costs and related processes. Appendix A presents the results of a survey of manufacturers of equipment which may be useful in implementing marginal cost pricing. Appendix B is a consideration of experimental design for testing the hypotheses on which marginal cost pricing is premised. Appendix C is a listing of the computer programs discussed in Section 3.

41275 Models for analyzing and forecasting economic characteristics of steam power plants. Arzamastsev, D.A.; Marder, L.I.; Myzin, A.L. *Izv. Akad. Nauk SSSR, Energ. Transp.;* No. 3, 94-101(1975). (In Russian).

Economico-statistical models of economic characteristics of power plants are considered. Results of modeling are illustrated by an example of determination of capital investments in condensing power plants. Two information levels of modeling--energy-economic and engineering-geographic--are singled out. To obtain a model of the energy-economic level, step regression analysis is used. It is shown that consideration of energy and economic factors alone leads to a large zone of indeterminacy in modeling. This zone of indeterminacy can be narrowed by taking into account the engineering and geographic group of parameters. The specific character of the problem at this level requires the use of special methods of statistical analysis. A method of modeling is proposed using factor and component analysis.

FUELS

REFER ALSO TO CITATION(S) 40979

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 41649, 41652

THERMAL EFFLUENTS

41276 (PB—2556097) **Selected aspects of waste heat management: a state-of-the-art study. Final report.** Serper, A. (Equitable Environmental Health, Inc., Woodbury, N.Y. (USA)). Jun 1976. 510p. NTIS $12.75.

A review is given of the state-of-the-art in: (1) treatment of evaporative cooling systems and offstream cooling system effluents; (2) determination of additional treatment required to utilize wastewater from sewage treatment plants as makeup for cooling systems and boilers; (3) determination of the state-of-the-art of mathematical modeling for power plant cooling systems and discharges; (4) examination of field monitoring programs; identification of current and recent field monitoring programs; (5) identification of scope and direction of present research to reduce the capital cost and penalties associated with dry cooling towers; and (6) identification of areas where future research is needed.

NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL

REFER ALSO TO CITATION(S) 40986, 41266

41277 (PB—255952) **Feasibility of a single tall stack in power plant construction. Final report.** Hamburg, F.C. (TRW/Environmental Services, Vienna, Va. (USA)). Jun 1975. Contract FEA-C-04-50080-00. 102p. NTIS $5.50.

The use of a single stack to serve a power plant with multiple boilers is analyzed as a possible alternative to multiple tall stacks for pollution abatement. The technique is of special interest because of its particular applicability to power plants for which intermittent control systems are contemplated. The analysis indicates that a single stack serving multiple boilers is more effective than much taller multiple stacks in reducing ground level SO_2 concentrations. Furthermore, the single stack is considerably less costly to install and maintain compared with multiple tall stacks, and should be less objectionable to aviation interests and aesthetic sensitivities. Whether considered for new plants or retrofitting existing plants, and whether or not scrubbers are used, the single stack appears to be a practical and economically attractive alternative for pollution abatement.

41278 (PB—255978) **Simplified procedures for estimating flue gas desulfurization system costs. Final report May 74—Apr 76.** Ponder, T.C. Jr; Yerino, L.V.; Katari, V.; Shah, Y.; Devitt, T.W. (PEDCO-Environmental Specialists, Inc., Cincinnati, Ohio (USA)). Jun 1976. Contract EPA-68-02-1321. 435p. NTIS $11.75.

The report given presents procedures for estimating the capital costs and annualized operating costs for five flue gas desulfurization (FGD) systems: lime, wet limestone, magnesium oxide, Wellman-Lord, and double alkali. Two methods are given for calculating the costs for the five systems: a detailed, flexible nomograph procedure, and a rapid equation procedure. All items that affect the capital and annualized operating costs of FGD systems in these estimating procedures are identified. Costs estimated by the procedures are compared with actual costs incurred by FGD system operators. Any differences between the estimated and actual costs are accounted for; the estimating procedures are modified when necessary.

41279 (PB—261918) **Comparative U.S./USSR tests of a hot-side electrostatic precipitator. Final report, Jan 1975—Sep 1976.** Gooding, C.H.; McCain, J.D.; Sommerer, D.K. (Research Triangle Inst., Durham, N.C. (USA)). Jan 1977. Contract EPA-68-02-1398. 74p. NTIS, PC A04/MF A01.

A U.S./USSR cooperative test program is described to quantify and characterize particulate emissions from a U.S. coal-burning power plant boiler, equipped with a hot-side electrostatic precipitator, at Duke Power Co.'s Allen Steam Station in March 1976. U.S. and Soviet equipment and procedures were used to determine flue gas composition and velocity, total particulate mass concentration of the gas stream, particle size distribution, electrical resistivity of the particulate entering the precipitator, evidence of back corona in the precipitator, SO_2 and SO_3 concentrations in the flue gas, and chemical composition of the fuel and fly ash. The test site and test procedures are described. Results of the comparative tests are presented and discussed. In 1972, the U.S. and the USSR signed a bilateral agreement pledging cooperation on environmental protection. This is one of the cooperative programs resulting from the agreement.

41280 Clean use of coal at the Hadera power station. Delson, J.K. (Ben Gurion Univ of the Negev, Beersheva, Isr). *Adrikhalut;* **34**: No. 1, 51-44(Jan 1975).

In addition to oil, imported high volatile bituminous coal will be used at the proposed new power station near Hadera, though for reasons of availability --rather than of economy. The emission of sulfur dioxide, SO_2, by burning coal is the most difficult problem that will be faced. Some relief can be found in using low-sulfur coal in removing SO_2 from the flue gas and in using tall chimney stacks. Initial removal of part of the sulfur by beneficiation at the coal mine is also desirable. Even so, removal of SO_2 from the flue gas will still be necessary. Present practice is to employ an alkaline reactant such as pulverized limestone. An additional need is the removal of flue-ash emission, using electrostatic precipitators. Plates and diagram complement description.

41281 Prevention of dust pollution from boilers. Jain, K.C. (Madhya Pradesh Electr Board, Korba, India). *J. Inst. Eng. (India), Min. Metall. Div.;* **56**: 43-48(1 Jul 1975).

Production of ash and dust from various types of boilers used at present in industry is described, followed by a review of the principle and operation of various types of dry type collectors that are employed for reduction and prevention of ash and dust emission from boilers. Various practical factors which affect the operational efficiency of boilers are discussed. A comparison of long-term efficiencies of different arrestors fitted to pulverized fuel-fired boiler installations is also made.

41282 Device for saving fuel and cleaning off-gas in heating installations. Monteux, C. German(FRG) Patent 2,613,223/A/. 7 Oct 1976. 14p. (In German).

3 figs.

The device, according to the invention, is mounted between flue-gas duct and stack for smaller, intermittently heated boilers and on top of the stack for larger boilers. With smaller boilers, only a damper is provided which closes when the burner is shut down to prevent the hot combustion gases from escaping into the open air and in order to slow down the cooling of the heating plant. For larger heating plants, the smoke from the stack is zigzagged before being released in order that the soot may be deposited. After shutting down the burner, an additional counter-draft prevents the hot waste gases from escaping into the open air.

SITE SELECTION AND LAND USE

41283 (PB—254743) **Economics of power plant siting in southeastern New England. Final report.** Gates, J.M.; Meade, N.F.; Sutinen, J.G. (Rhode Island Univ., Kingston (USA). Dept. of Resource Economics). Jun 1974. 105p. NTIS $5.50.

Sponsored in part by New England River Basins Commission, Boston, Mass.

The four major topics are discussed, i.e. demand and supply of electrical energy in the SENE region; the economics of expanding supply of and managing demand for electrical energy in SENE; the economics of locating power plants; and the economic implications of fifteen alternative power plant sites. The major sources of demand in the SENE region are Boston and Providence. Fossil fuel expansions in these areas will have to contend with higher fuel prices in the future and strict air quality standards. This will create incentives for fossil fuel facilities in outlying communities and for coastal

nuclear plants where adequate cooling water exists. Considerations affecting the choice of sites are: public health and safety; environmental quality and zero emissions; resistance on the part of land owners to sell sites for power plants; and local regulations on transmission lines.

41284 Site selection of lignite-fed power plants based on fuel supplies. Goergen, H.; Hupp, H.; Zoellner, G. (Tech Hochsch, Aachen, Ger). *Foerdern Heben;* **25**: No. 8, 797-801(Jun 1975). (In German).

Factors to be taken into consideration in planning the power plants are discussed. The influences of such factors are affected by the site of the source of primary fuel and/or the main features of the power requirement. The degree of latitude that can be allowed with high-ballast fuels, in choosing the site of the power station must be decided upon in each separate instance. The fact that this is also limited a great deal by contrary or conflicting influences was proved in the course of an investigation carried out in projecting a lignite mine in Northern Spain, where the power station was to be the sole consumer of the fuel obtained.

POWER TRANSMISSION AND DISTRIBUTION

41285 Survey of high-output transformers and a look at possible future developments. Gasper, W. *Brown Boveri Rev.;* **63**: No. 7, 421-431(Jul 1976).

To enable the continuous growth in demand for electricity to be satisfied economically, generator and substation transformers with progressively higher ratings are required. Particularly during the past decade the limitations on output have been extended markedly. The major factors for the achievement of this progress have been the objective development work carried out to cope with the problem of very high outputs and increasing the capabilities of transport equipment.

41286 Transformers manufactured in brazil. Hurter, T.; Wolfensberger, A.; Nogueira, V. *Brown Boveri Rev.;* **63**: No. 7, 442-449(Jul 1976).

In part one of this article, the authors give a short review of electrical energy in Brazil and describe the role played by Brown Boveri in transformer manufacture. In part two, the design of an intricate 440/362 kV autotransformer is fully discussed.

41287 Standard transformers for 2 to 100 MVA. Kreuzer, J. *Brown Boveri Rev.;* **63**: No. 7, 450-454(Jul 1976).

Following a review of past developments and a description of the present situation in the field of medium-size power transformers, the economic significance of standardization is underlined. Subsequent sections indicate in parameter form the marketing requirements that have to be considered, and the limits of standardization in this respect. Technical, manufacturing and other possibilities contributing to the reduction of costs and prices are discussed and, finally, the major question posed by every customer as to whether the economy measures taken might reduce the reliability of the product, is gone into at length.

41288 Service experience with distribution transformers without oil conservators. Kaesermann, P. *Brown Boveri Rev.;* **63**: No. 7, 462-464(Jul 1976).

In Switzerland all distribution transformers up to a rating of 1000 kVA are supplied without oil conservators and are of the open type with two breathers on the tank cover. Various technical and service aspects dealt with in detail in this article substantiate that this solution is fully justified.

41289 Formulation and computer methods of load flow studies. Silvestri, A. (Univ di Pavia, Italy). *Elettrotecnica;* **63**: No. 8, 689-700(Aug 1976). (In Italian).

The aim of this work is to present, the load-flow studies in their formulation and statement, following their progressive development through rather frequent bibliographic references and indicating, at the same time, the calculation procedures usually employed for their resolution. After a survey of classical solution methods, more recent techniques involving optimization and nonlinear programming algorithms are presented. Additionally, some numerical methods for solving unconstrained and constrained minimization problems are proposed in appendices.

41290 Using electronic data processing equipment for complotting supply grids. Mauer, A. (Stadtwerke Karlsruhe (Germany, F.R.)). *Gas- Wasserfach, Gas-Erdgas;* **118**: No. 1, 23-26(Jan 1977). (In German).

An electronic data processing system in a public utility (gas, water, electricity, district heat) should fulfil the following functions: (1) documentation for planning, construction, operation and maintenance of the supply grids, (2) grid calculations, and (3) graphic plotting of readable plan. A change from manual plotting to graphic data processing alone does not seem economical.

AC SYSTEMS, EHV AND UHV

41291 High voltage polyethylene insulated cables from 63 to 225 kV and their fittings. Favrie, E. (Soc Ind de Liaisons Electr, Fr). *Rev. Gen. Electr.;* **85**: No. 9, 725-729(Sep 1976). (In French).

After describing the different constituents of high voltage cables, the problems linked to manufacturing technology are considered. The fittings for these cables, i.e., junctions and terminations, constitute elements which are difficult to make. An original method is submitted, notably for making cable terminations up to a voltage of 110 kV.

41292 Materials for high voltage cables with polyethylene or chemically cross-linked polyethylene insulation. Demay, J.N.; Bobo, J.C. (Les Cables de Lyon, Fr). *Rev. Gen. Electr.;* **85**: No. 9, 731-736(Sep 1976). (In French).

This article relates to the materials used for the manufacture of high voltage electric cables provided with extruded synthetic insulation. The field of insulants concerned is limited to high and low density polyethylenes and to chemically cross-linked polyethylene. The characteristics of the various constituents entering into the composition of the insulant or semi-conductor compounds are dealt with at length, as well as the influence of some of them on the technology of cable manufacture.

41293 Contribution to the study of initiation and propagation mechanisms of treeing in polyethylene for high voltage cables. Perret, J.; Le Gall, Y.; Recoupe, P. (Electr de Fr). *Rev. Gen. Electr.;* **85**: No. 9, 737-747(Sep 1976). (In French).

The analysis of numerous studies on treeing phenomena taking place in synthetic insulations, especially those of cables, shows that the basic mechanisms involved are not yet completely understood. A contribution to the study of the initiation and propagation of treeing in polyethylene for high voltage cables is presented. Tests on samples and investigations on insulations of cables failed in service or during tests were carried out. Some important factors affecting the initiation and propagation of treeing have been pointed out; a satisfying interpretation will be possible only after the achievement of fundamental studies. 64 refs.

41294 Computer-operated ripple control command unit. Buurman, E.; Paessler, E.R. (Siemens, Erlangen, Ger). *Siemens Rev.;* **43**: No. 9, 377-381(Sep 1976).

Due to the increasing demands made upon them, the command units in audio-frequency ripple control systems are normally controlled by process computers. By integrating the 310 process computer as a dedicated computer in the RKG31 ripple control command unit, an automation aid was created which can be used in all known ripple control systems at quite moderate cost. Operation is simplified and remote control of the system facilitated by use of the modular principle. 4 refs.

41295 380 kV single-core oil-filled cables and fittings. Peschke, E.F. (Siemens, Berlin, Ger). *Siemens-Z.;* **50**: No. 10, 676-684(Oct 1976). (In German).

The introduction of oil-filled cables just 50 y ago permitted a major breakthrough from primary-distribution voltage to ehv transmission levels. The demands placed on 380 kV cables and exacting safety requirements can only be met by careful selection of materials, specially designed insulation and the use of the most modern plant. The successful use of 380 kV single-core low-pressure oil-filled cables is described.

41296 New ways for upgrading thermoplastic PE and cross-linked PE-insulated power cables. Eichmann, D.; Schroeder, G. (Siemens, Berlin, Ger). *Siemens-Z.;* **50**: No. 10, 685-690(Oct 1976).

Thermoplastic and cross-linked PE insulated cables are now competing with conventional paper-insulated cables not only for low and primary-distribution voltages but also for ratings up to 110 kV. The manufacturing methods have to be of an extremely high standard to ensure the necessary quality of the thermoplastic material. This article deals with the new plant at the Siemens cable factory in Berlin and the characteristics of the cables made there.

DC SYSTEMS

41297 High voltage dc transmission applications offshore. Bergstrom, L.A.; Eriksson, K. (ASEA Ltd, Montreal, Que). pp 275-280 of In 23rd annual conference of the Institute of Electrical and Electronics Engineers. New York; Inst. of Electrical and Electronics Engineers (1976).

From 23. annual conference of the Institute of Electrical and Electronics Engineers; Philadelphia, PA, USA (30 Aug 1976).

An increasing number of oil and gas fields are today being located and developed offshore. In some cases it may not be feasible to build pipe lines to bring the gas or oil ashore. This paper presents an alternative solution for bringing the energy ashore, which is technically feasible by the use of High Voltage dc Transmission technology, and which is economically feasible under certain condi-

tions. This concept is based on locating a gas turbine driven power plant on an offshore platform from which the energy is taken ashore with a dc cable. This type of plant could be applied for developing so-called satellite fields which would otherwise be uneconomical to develop.

41298 Static convertor transformers for the hvdc transmission link Cabora Bassa-Apollo. Bold, H. *Brown Boveri Rev.;* **63**: No. 7, 432-441(Jul 1976).

Dielectric, magnetic, mechanical and harmonics-specified stresses in hvdc transformers are described. Dielectric tests, as yet not covered by specifications, are explained. The design of transformers built by Brown Boveri is discussed. A brief report of some noteworthy test results concludes the article.

SUPERCONDUCTING AND CRYOGENIC SYSTEMS

41299 Superconducting power transmission: the perils and promise. Forsyth, E.B. (Brookhaven Natl Lab, Upton, NY). *Energy (Oxford);* **1**: No. 2, 111-122(Jun 1976).

The development of bulk electricity transmission systems must be considered in the light of changing growth rates, increasing resistance to ehv overhead transmission and the tendency to concentrate generation in fewer sites. Helium-cooled, or superconducting, cables possess technical characteristics which will make them suitable as utility network components for power transmission over distances of ten to several hundred miles. These properties are illustrated by considering two applications in existing electrical networks. The first is a 43 mile system to transmit 4800 MVA and the second is a potential application under study in Pennsylvania to transmit 10,000 MVA over a distance of 350 miles or so. Helium-cooled versions of these transmission systems were designed to permit technical and economic evaluations. The major groups and institutions throughout the world engaged in the development of helium-cooled cables are listed and aspects of the technical approaches are briefly described.

NUCLEAR POWER PLANTS

REFER ALSO TO CITATION(S) 41661

41300 (CS-INIS—26) **New nuclear power plants in the German Federal Republic. Part 1 of a report on nuclear power plant projects in Europe.** (Energoprojekt, Prague (Czechoslovakia)). Mar 1975. 37p. (In Czech). (P—203/75). Dep. NTIS (US Sales Only), PC A03/MF A01.

Translated from ATW (1974) (no.4) p. 183-197. Available from Energoprojekt, stredisko technickych informaci, Prague 7, Czechoslovakia.

Ten plants with a total output of 2,396 MWe were in operation in the Federal Republic of Germany in March 1974, another 10 plants were under construction with a total output of 9,092 MWe, and 13 power plants with a total output of 15,542 MWe were planned. The basic characteristics are given of the power plants under construction and those that were planned. The stage of unfinished plants is assessed.

41301 (IAEA-CN—36/6) **Co-operation of the CMEA member countries in the developing power reactors of various types, including some aspects of their nuclear fuel cycles.** Barbur, I.; Barchenkov, A.; Molnar, L; Panasenkov, A.; Tolpygo, V.; Hake, V.; Shcherbinin, B. (International Atomic Energy Agency, Vienna (Austria)). 1977. 29p. (In Russian). (CONF-770505—241). Dep. NTIS (US Sales Only), PC A03/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

1.A.-.P.1./02 Also available in English.

The report gives an account of the problems of projected development of atomic power and evaluates its role in the fuel and power complex and long-range development of interconnected power systems of the CMEA member countries. The report emphasizes the importance of scientific and technical co-operation in the creation of power reactors on thermal and fast neutrons with 1000-1500 MW unit electric capacity as well as in the elaboration of nuclear plants for heating services. It notes the positive experience of the International scientific and research group of scientists of the CMEA member countries carrying out reactor-physical studies on the critical assembly and its contribution to the elaboration of power reactors. The report contains basic conclusions from the development forecast for nuclear power of the CMEA member countries up to 1990 including forecasting methodology; role of nuclear power plants in saving natural and enriched uranium for a projected period; impact of nuclear power development rates on its structure (thermal and fast reactor ratio); relation between the beginning of mass commissioning of nuclear power plants with fast reactors and the integral demand for nuclear fuel; scale of required capacities of fuel cycle services; time dependence of fuel cycle on nuclear fuel requirements. It examines the problems and lists the results of scientific and technical co-operation of the CMEA member countries in the field of fuel cycle, including the transport of spent nuclear fuel, its recovery, reprocessing and radioactive waste disposal. Questions of co-operation of the CMEA member countries to secure radiation safety of nuclear power plants and environmental protection are analyzed. The report notes the role of international economic associations - "Interatomenergo" and "Interatominstrument" - in the accelerated development of nuclear power on the basis of cooperation and specialization in the manufacture of equipment for nuclear power plants.

41302 (IAEA-CN—36/53) **UK experience of planning the nuclear contribution to the UK power programme.** Catchpole, S.; Jenkin, F.P. (International Atomic Energy Agency, Vienna (Austria)). 1977. 9p. (CONF-770505—243). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

1.B.2.P.1./02 3 figs.

The paper outlines U.K. experience in planning nuclear programmes. It examines the factors which have determined the size of such programmes together with those factors which have influenced their implementation. The paper also discusses the role which the utility has played in the deployment of nuclear power in the U.K. At present, nuclear energy can only be utilised on a large scale via the electricity route and the forecasting of electricity demand is therefore a key element in determining the size of the nuclear programme. Other important issues which affect the nuclear contribution are: national fuel policies, discontinuities in price and availability of imported fossil fuels, plant capital costs, fuel price relativities, plant siting, rate of introduction of new nuclear systems, manufacturer's capability, public attitudes towards nuclear power and financing. These issues are dealt with in some detail including their relative importance in the U.K. The paper also discusses the contribution of the various nuclear bodies in the U.K. in securing the implementation of the nuclear programmes. From the inception of nuclear power in the U.K., it has been recognised that a major utility has a central role to play not only in commercial operation but also in the procurement of plant and materials. As explained in the paper this "informed buyer" approach, which is being increasingly adopted by other major utilities, calls for an organisation and technical infrastructure far more complex than is the case for fossil plants. The requirements of safety, which is unambiguously the responsibility of the utility, and of high availability of plant operation demand a rigorous approach to design, quality assurance, project management, construction and operation. To this must be added sound research and development and staff training facilities. The paper explains how experience in these vital areas has been built up.

41303 (IAEA-CN—36/162) **Plutonium utilization in thermal and fast reactor in Japan.** Amanuma, T.; Uematsu, K. (International Atomic Energy Agency, Vienna (Austria)). 1977. 13p. (CONF-770505—132). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.A.1.P.1./02 5 tables, 3 figs.

Nuclear power development in Japan is rather extensive. The installed nuclear power capacity is expected to reach 49,000 MWe by 1985 and possibly to reach 170,000 MWe by 2000. Currently installed nuclear power is mainly based on the Light Water Reactor, and this trend is expected to persist for the time-being. The plutonium produced by LWR will be accumulated to 20 tons by 1985 and to more than 200 tons by 2000. If the produced plutonium will simply be stored, it will raise the economic pressure to utilities and the management and physical protection problems associated with plutonium storing. Therefore, it is not too wise simply to store plutonium in a locked vault. In Japan, there are three ways of solving these problems which are currently worked out. There is no doubt that the best solution is to use plutonium in fast reactors. To reach this goal, an Experimental Fast Reactor "JOYO"has been constructed and it is waiting for criticality in very near future. A prototype fast breeder reactor "MONJU", which is designed for about 300 MWe, is nearing the last stage of the design work. The start of its construction will take place in a few years. The demonstration fast breeder reactor will come next to "MONJU" and the large scale commercial use of fast breeder reactor is expected to start around 1995. To anwer the near-term need for plutonium utilization, two technologies, which are equally important to Japan, are currently developed. One is the recycle use of plutonium into LWR. This technology has long been jointly developed by research organizations and utilities. Some of fuel irradiation data are already obtained and the physics study has also been extensive. The application of this technology is expected to start about 1987. The other is to burn plutonium in an Advanced Thermal Reactor (D_2O moderated, Boiling Water Cooled) which shows better characteristics of using plutonium.

41304 (IAEA-CN—36/365) **European Community care for nuclear power.** Charrault, J.C.; de Nordwall, J.H.; Viseur, R.; Vivante, C.; Graziani, G.; Rinaldini, C.; Zanantoni, C. (International Atomic Energy Agency, Vienna (Austria)). 1977. 4p. (CONF-770505—244). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

8.0.-.T.1./04 10 figs.

In recent times a large number of studies have investigated the various policies which can be followed to satisfy a given electric energy demand. Installation policies concerning conventional stations and several types of nuclear stations have been analyzed from the point of view of consumptions, expenditures, investments etc. The exercise is usually repeated for several demand-growth curves. Sometimes an optimization of the power station installation policy based on minimizing consumption of a type of fuel or expenditures is made. In the study presented here a different attitude is taken, in the sense that it is assumed that the energy demand growth will be large enough to justify the growth of nuclear energy production; this will be limited by a number of technological constraints, namely: 1- The Uranium delivery rate. This rate (tons/year) is assumed to increase from 1985 by 10% per annum and to reach a saturation level after a given number of years. 2- Availability of reprocessing capacity. It is assumed to increase with a given doubling time after 1985. 3- Development of reprocessing technology, which is represented here by the out-of-pile time of the fuel. 4-Availability and technology of fast reactors, represented by the year of first installlation and by their physical characteristics. All the values defining the above-mentioned constraints are varied parametrically and their effects on the penetration of thermal and fast reactors and on the consequent consumptions and expenditures are assessed. A few considerations on the demand of conventional energy resulting from such constraints and from various hypotheses on the total demand are made, to show that a considerable production of conventional energy must be foreseen in the next few decades.

41305 (IAEA-CN—36/420) **Development of the national nuclear programme and preparations for the introduction of nuclear power in Hungary.** Szili, G.; Erdosi, N.; Varga, I.; Gyimesi, Z.; Ocsai, M.; Szabo, B. (International Atomic Energy Agency, Vienna (Austria)). 1977. 22p. Dep. NTIS (US Sales Only), PC A02/MF A01.

7.0.-.P.1./04 1 table. Also available in Russian.

Hungary's energy situation, energy policy and its interest in the use of nuclear energy are reviewed and the main nuclear power programme targets for the medium term (by 1990) and long term (by 2000) are given. Preparatory steps for the introduction of nuclear energy are outlined, emphasizing the important areas of the preparatory programme. A short technical description is given of Hungary's first nuclear power plant, the Paks Nuclear Power Station, including the preparations for construction and erection, the present construction plan, fuel supply, basic technical aspects of safety, and the social consequences of the plant's erection. The problems involved in the introduction of nuclear energy that must be solved by the state administration are summarized. A review is given of earlier legislation on projects and works representing a radiation hazard; duties are discharged by different state administrations.

41306 (IAEA-CN—36/459) **Indian experience in the training of manpower for nuclear power programme.** Iyengar, P.K.; Damodaran, K.K.; Sarma, M.S.R.; Wagadarikar, V.K. (International Atomic Energy Agency, Vienna (Austria)). 1977. 8p. (CONF-770505—149). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

7.1.-.T.2./07 2 tables.

In India manpower training for the nuclear power programme started several years before the introduction of nuclear power plants. Early efforts were concentrated on developing manpower in basic sciences related to nuclear power; for example, nuclear physics, chemistry, metallurgy of nuclear materials, aspects of chemical engineering etc. The setting up of the research centre viz. Atomic Energy Establishment Trombay, now named the Bhabha Atomic Research Centre, was an important step in this direction. A programme of design and construction of research reactors and its utilization formed the backbone of manpower development. This enabled the first batch of engineers and scientists to be trained on the design and operation in the programmes connected with research reactors and use of isotopes in industry, agriculture and medicine. The next step was to establish a Training School in the Bhabha Atomic Research Centre in which fresh graduates from the Universities could be given courses both in their own disciplines and in other inter-connected disciplines of nuclear sciences. About 200 such graduates are being trained every year since 1957. An interdisciplinary approach with teaching by working scientists and engineers and the attachment for short periods to the research laboratories is the framework of this training programme. At present about 3000 graduates from this Training School are involved in various capacities in India's nuclear power programme. With the commissioning of the first power reactors, it became necessary to conceive of training engineers, scientists and technicians, particularly for operation and maintenance of such systems on a larger scale. For this purpose, a separate training institute at Rajasthan Atomic Power Project near Rana Pratapsagar was set up. Models, simulators and courses, particularly emphasizing the heavy water system of reactors was introduced.

41307 (IAEA-CN—36/462) **Experience in the manufacture of nuclear equipment in India.** Challappa, S.; Murthy, G.S.K.; Mehta, S.K.; Kakodkar, A.; Natarajan, A. (International Atomic Energy Agency, Vienna (Austria)). 1977. 7p. (CONF-770505—130). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

7.3.-.T.1./05.

Department of Atomic Energy with its programme for achieving self-sufficiency was involved in engineering, manufacture, inspection, performance testing and quality surveillance of major precision and critical equipment such as reactor vessels, shields, fuelling machines, coolant channel components, high pressure equipment for heavy water plants, specialized components for the Fuel Complex, major equipment for the Cyclotron Project and various research projects. These had to be manufactured at various shops in the country depending upon the availability of machines. The relative importance of various important parameters associated with the manufacture of this equipment was assessed in a separate R and D programme. This has helped in re-designing in some areas to suit the manufacture under Indian conditions. Assessment of any marginal variations that take place during manufacture was also possible because of the availability of data of this kind. Critical components and equipment are tested for their performance under simulated conditions before shipment. B.A.R.C. has contributed immensely in achieving the self-sufficiency and also for designs for future plants.

41308 (IAEA-CN—36/464) **Contribution of nuclear energy to the meeting of Italy's electric power requirements.** Angelini, A.M. (International Atomic Energy Agency, Vienna (Austria)). 1977. 16p. (CONF-770505—239). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

1.B.2.P.1./01.

Paper discusses ENEL's policy in the development of nuclear energy, which assigns to this source the role of meeting almost all of Italy's additional future power requirements. This is a position taken some time ago and already outlined on the occasion of the Geneva Conference of 1971. Policy is based on number of factors, reviewed in the paper, which differentiate, at least in quantitative terms, Italy's situation from that of most industrialized countries. Among these factors stand out the scarcity of natural resources, including energy sources. An extensive recourse to nuclear energy is the best way to achieve that diversification of energy supplies vital to the Italian economy which, because of the very lack of natural resources, is predominantly based on processing. While the Caorso Nuclear Power Plant (840 MW) is due to go into service soon, ENEL's nuclear plan, recently approved by the Government, calls for the construction of the four 1,000-MW units already on order and of 16 additional units, of the same size, divided into two 8-unit blocks, to be decided on respectively in the very near future and before the end of 1977. The necessary flexibility of the plan concerning the nuclear units that will go into service by the 1986 is ensured by the subdivision into blocks, with provision for the postponement of the second, 8-units block in the country's economy development requires a revision in electric power forecasts. The paper then considers in particular the integration between the nuclear plan and ENEL's extensive plan for pumped-storage hydro-electric power plants and the related technical and economic advantages which also extend to an international scope. The paper concludes the review of Italy's nuclear plan by stressing two essential problems: financing and the availability of sites for nuclear power plants. The paper supplies some information concerning the nuclear research, development and demonstration activities connected with the long-term plans.

41309 (IAEA-CN—36/483) **Recent U.S. reactor operating experience.** Stello, V. Jr. (International Atomic Energy Agency, Vienna (Austria)). 1977. 14p. (CONF-770505—159). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

4.1.-.T.1./11.

A qualitative assessment of U.S. and foreign reactor operating experience is provided. Recent operating occurrences having potentially significant safety impacts on power operation are described. An evaluation of the seriousness of each of these issues and the plans for resolution is discussed. A quantitative report on U.S. reactor operational experience is included. The details of the NRC program for evaluating and applying operating reactor experience in the

regulatory process is discussed. A review is made of the adequacy of operating reactor safety and environmental margins based on actual operating experience. The Regulatory response philosophy to operating reactor experiences is detailed. This discussion indicates the NRC emphasis on the importance of a balanced action plan to provide for the protection of public safety in the national interest.

41310 (INIS-mf—3391, pp 69-87) **Main ways of nuclear power development.** Smatlak, S. (Federalni Ministerstvo Paliv a Energeticky, Prague (Czechoslovakia)). Jun 1975. (In Slovak).

From 10. meeting of Czechoslovak power engineers; Kosice, Czechoslovakia (4 Jun 1975).

In Proceedings of the 10. meeting of Czechoslovak power engineers. Electric power base construction, part 1.

The construction of power plants in Czechoslovakia may basically be divided into four periods: (1) the period of the orientation of the Czechoslovak industry to the building, equipping, and operating of nuclear plants with 440MW WWER reactors; (2) the period of the advanced building of nuclear power plants with WWER 440 reactors and the transition to higher unit output; (3) the period of the parallel construction of large nuclear power plants with thermal reactors and large units with fast breeder reactors; and (4) the period of the construction of mostly fast breeder reactors and other improved types. The individual periods are evaluated with regard to the preparedness of the Czechoslovak industry and to international cooperation within the Council of Mutual Economic Assistance. A comparison is made of nuclear and conventional power plants with regard to economy and to their environmental impacts.

41311 **Italian nuclear activities in 1974.** Battistini, G. *Igegnere;* **50**: No. 6, 259-268(Jun 1975). (In Italian).

After briefly summing up the general energy situation, the Italian nuclear electric power plant development program is described. Industrial activities of various enterprises, research and technological development are briefly summarized.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

REFER ALSO TO CITATION(S) 41331, 41429, 41436, 41492, 41494, 41511, 41515, 41520, 41525, 41526, 41530, 41534, 41536, 41538, 41544, 41553, 41555

41312 (ANL—76-75) **Summary on experimental methods for statistical transient analysis of two-phase gas-liquid flow.** Delhaye, J.M.; Jones, O.C. Jr. (Argonne National Lab., Ill. (USA)). Jun 1976. Contract W-31-109-ENG-38. 70p. Dep. NTIS, PC A04/MF A01.

Much work has been done in the study of two-phase gas-liquid flows. Although it has been recognized superficially that such flows are not homogeneous in general, little attention has been paid to the inherent discreteness of the two-phase systems. Only relatively recently have fluctuating characteristics of two-phase flows been studied in detail. As a result, new experimental devices and techniques have been developed for use in measuring quantities previously ignored. This report reviews and summarizes most of these methods in an effort to emphasize the importance of the fluctuating nature of these flows and as a guide to further research in this field.

41313 (BNWL—2152) **Evaluation of Millstone Nuclear Power Plant, Environmental Impact prediction, based on monitoring programs.** Gore, K.L.; Thomas, J.M.; Kannberg, L.D.; Watson, D.G. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Feb 1977. Contract EY-76-C-06-1830. 88p. Dep. NTIS, PC A05/MF A01.

This report evaluates the nonradiological monitoring program at Millstone Nuclear Power Plant. Both operational as well as preoperational monitoring programs were analyzed to produce long-term (5 yr or longer) data sets, where possible. In order to determine the effectiveness of these monitoring programs, the appropriate data sets have to be analyzed by the appropriate statistical analysis. Thus, both open literature and current statistical analysis being developed at Pacific Northwest Laboratories (PNL) were employed in data analysis.

41314 (CS-INIS—27) **Philippsburg nuclear power plant 380 KV switching station.** Kriechbaum, K.; Kulik, P.; Stober, E. (Slovenska Technicka Kniznica, Bratislava (Czechoslovakia)). [nd]. 11p. (In Czech). (P—22122). Dep. NTIS (US Sales Only), PC A02/MF A01.

Translated from Elektrizitaetswirtschaft (1973) v. 72(6) p. 139-147. Available from Slovenska Technicka Kniznica, Bratislava, Czechoslovakia.

The 900 MW output of the Philippsburg power plant, currently under construction, will be connected to the 380 kV electrical power system by a switch plant which must insure that eventual switch plant failures do not necessarily result in loss of the nuclear power unit output. The concept of the switch plant is subordinated to this demand and to the demand for maximal safety. The diagram of the basic connection and the selection of the respective equipment are described.

41315 (IAEA-CN—36/89) **Arguments for the installation of small LWR nuclear power plants in developing countries.** Lezenik, B. (International Atomic Energy Agency, Vienna (Austria)). 1977. 17p. (CONF-770505—154). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

7.2.-.T.1./01 3 graphs.

The differences disclosed in the IAEA-Report "Market Survey..." before and after the drastic increase of the oil price in 1973 indicate most unequivocally the growing economic profits of the application of nuclear power plants with smaller output. The report furthermore demonstrates in clear terms the benefits of a long-term fuel arrangement as is applied for nuclear power plants. Following these basic considerations, according to which the construction of nuclear power plants appears to be reasonable, economically speaking, the next important criterion having priority, as far as the technical aspect is concerned, is the question concerning the largest possible unit to be integrated into the grid. So as to ensure a steady mains power supply, the structure of operating power plant types, their number and unit sizes as well as their controllability and load-following behavior have to be coordinated with one another individually. As an example for the nuclear power plant Borssele (450 MW - PWR) which has been in operation since 1973, basic control concepts are outlined which together with the load-following behavior of this reactor meet the grid requirements. This is to demonstrate the flexible application of this reactor type. Manufacturing and operating experience as well as the accumulated know-how concerning design and construction of large plants in the 1200/1300 MW class offer a broad basis for the standardization of the smaller LWR-plants. The experience gained with proven components and approved systems for the fully standardized 1200/1300 MW reactors equally guarantees operating reliability and availability, since differences in output are realized by means of additive modifications of the primary system components. A comparison with, and an interpretation of, the essential design data outline the progress achieved in the standardization process.

41316 (IAEA-CN—36/474) **Fuel reliability in light water reactors, experience and assessment for the future.** Rolstad, E.; Boerresen, S. (International Atomic Energy Agency, Vienna (Austria)). 1977. 5p. (CONF-770505—156). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.4.-.T.1./02 7 figs.

The operation of the first generation of commercial reactors has demonstrated that fuel rods are more delicate and need more attention than earlier anticipated. Three distinctly different failure modes have been responsible for most of the failures. These are: The hydride failures, densification failures, and PCM failures. Hydride and densification failures have now been eliminated by better production techniques and improved specifications on water control and pellet sintering procedures and can consequently now be looked upon as infantile diseases. The PCMI (or power-shock) type of failure is, however, a more chronical problem which still exists in spite of a number of actions to eliminate this. The first of these actions were a number of fuel design changes aimed at reducing PCMI. For example: shorter pellets, larger gap, interface lubrication, change in pellet end-shape, and different clad heat treatment. The effect of these changes were, however, only marginal. The next action was to introduce changes in the operating roles in order to reduce the power shocks on the fuel. An example is the GE (PCMOR) fuel conditioning rules. These rules made it just possible to operate the old 7 x 7 fueled reactors, but the number of failures was still excessive. The next action was therefore also to reduce the linear power rating on the fuel rods. GE did this by loading 8 x 8 fuel rods into assemblies with the same external dimension as earlier carried 7 x 7 rods, without increasing the assembly power. Westinghouse changed from 15 x 15 to 17 x 17 fuel rods. There is not sufficient experience yet with these 2nd generation of fuel, but the Oskarshamn BWR reactor has now completed its 3rd cycle with fuel similar to the new GE 8 x 8. This has shown an excellent fuel reliability as long as the reactor is carefully operated to avoid power-shocks, but one deliberate fast control rod withdrawal performed at the end of the 2nd cycle produced as many as 13 fuel assembly failures.

41317 (IAEA-CN—36/475) **Performance and reliability of LWR fuel.** Bairiot, H.; Deramaix, P.; Vandenberg, C. (International Atomic Energy Agency, Vienna (Austria)). 1977. 5p. (In French). (CONF-770505—205). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.4.-.T.1./04 1 table, 4 figs.

The main requirements for fuel reloads are: good reliability, minimum fuel cycle costs and flexibility of operation. Fulfilling these goals requires a background of experience. The approach to the acquisition of this experience in the particular case of BN has included over the last 15 years a proper development and cross-checking of the design methods and criteria, a continuous updating of the drawings and specifications and the qualification of adequate fabrication plants. The succession and progressive completion of the experience detailed in the paper is mainly based on the fact that before loading a fuel in a reactor at least 3 years of preparation are required if it is a first of the kind. The results can only be fully assessed if after the life-time in the power reactor (3 years for a PWR, 5 years for a BWR), a proper postirradiation assessment is performed which requires another 1 to 3 years taking into account the extent of the programme. The data acquisition is therefore a process requiring 9 to 10 years between the decision to go ahead and the full availability of the experience.

41318 (IAEA-CN—36/558) **Experience with Pu-recycle fuel for large light water reactors in the Federal Republic of Germany.** Stehle, H.; Spierling, H.; Eickelpasch, N.; Schenk, H.; Stoll, W. (International Atomic Energy Agency, Vienna (Austria)). 1977. 9p. (CONF-770505—158). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.5.-.T.2./03 3 tables, 8 figs.

In general, design and operational performance of Pu-bearing recycle fuel are quite similar to those of Uranium fuel. Up to Nov. 1976 153 Pu-bearing fuel assemblies with altogether 8000 fuel rods, fabricated by ALKEM, have been or are in operation in German power reactors. Their performance is very satisfactory. In the Obrigheim and in the Gundremmingen plant up to 20% of the core are made up of Pu-fuel. In either case all-Pu fuel assemblies are used, graded in their Pu-content for compatibility with the surrounding U-fuel. The physics calculations are accomplished with basically the same methods as applied for U-fuel. Theoretical investigations and physics measurements have shown that differences in reactivity balance can be minimized by proper loading patterns. In additional experiments at elevated temperature (KRITZ) the neutron physics methods were verified in greater detail. The main feature of fabrication of mixed oxide pellets is mechanical blending of natural UO_2- and PuO_2-powder before pressing green pellets, and a rather high degree of mechanisation in all fabrication steps including sintering, wet grinding, and rod filling operations. The Zircaloy cladding know-how, welding techniques, final surface treatment etc. were all taken from the large experience of KWU in the LWR fuel area. Several fuel assemblies have been examined in the spent fuel pools and in hot cell laboratories after a maximum burn-up of 30 GWd/t. The examinations revealed no significant differences compared to U-fuel. Fission gas release is somewhat higher, attributed to the inhomogeneous fissioning on the microscopic scale in the mechanically mixed oxide. For the same reason the rate of densification is reduced. No Pu-redistribution has been observed. β-scans (^{140}La) and isotopic analyses confirmed the adequate accuracy of the calculation methods.

41319 (IAEA-CN—36/566) **PWR and BWR light water reactor systems in the USA and their fuel cycle.** Crawford, W.D. (International Atomic Energy Agency, Vienna (Austria)). 1977. 20p. (CONF-770505—153). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

1.C.-.P.1./02.

Light water reactor operating experience in the USA can be considered to date from the choice of the pressurized water reactor (PWR) for use in the naval reactor program and the subsequent construction and operation of the nuclear power plant at Shippingport, Pennsylvania in 1957. The development of the boiling water reactor (BWR) in 1954 and its selection for the plant at Dresden, Illinois in 1959 established this concept as the other major reactor type in the US nuclear power program. The subsequent growth profile is presented, leading to 31 PWR's and 23 BWR's currently in operation as well as to plants in the planning and construction phase. A significant operating record has been accumulated concerning the availability of each of these reactor types as determined by: (1) outage for refueling, (2) component reliability, (3) maintenance requirements, and (4) retrofitting required by government regulation. In addition, the use and performance of BWR's and PWR's in meeting system load requirements is discussed. The growing concern regarding possible terrorist activities and other potential threats has resulted in systems and procedures designed to assure effective safeguards at nuclear power installations. Safeguards measures currently in place are described. Environmental effects of operating plants are subject to both radiological and non-radiological monitoring to verify that results are within the limits established in the licensing process. The operating results achieved and the types of modifications that have been required of operating plants by the Nuclear Regulatory Commission are reviewed. The PWR and BWR Fuel Cycle is examined in terms of: (1) fuel burnup experience and prospects for improvement, (2) the status and outlook for natural uranium resources, (3) enrichment capacity, (4) reprocessing and recycle, and the interrelationships among the latter three factors.

41320 (IAEA-CN—36/577) **Pu utilization in fast-breeder and in light-water reactors in Italy.** Mangiagalli, D.; Cicognani, F.; Pistella, F.; Testa, G.; Villani, A.; Ariemma, A.; Castelli, G.F.; Linari, A.; Paoletti Gualandi, M.; Musso, B. (International Atomic Energy Agency, Vienna (Austria)). 1977. 12p. (In French). (CONF-770505—195). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.5.-.T.1./04 1 table.

The paper illustrates the most important activities carried out in Italy for the development of fast breeder reactors and its fuel as well as for plutonium recycle in light water reactors. The Italian strategy is based, on one hand, on the short-term commercialization of fast breeder reactors, and on the other, on the adoption of the technology of the Phenix prototype whose further development will be ensured by the joint Italian and French efforts as insured by the important agreements signed by CNEN, NIRA (Nucleare Italiana Reattori Avanzati) and Italian manufacturing industries with CEA and the main French industries. The paper also includes the main results of the ENEL Demonstration Program on Pu prototypes introduced in the Garigliano BWR in 1968 and 1970, and of the destructive and non-destructive analyses on said fuel, as well as of the analyses carried out by CNEN on prototypical fuel fabricated by CNEN and irradiated in various reactors. Furthermore, the paper deals with design and licensing aspects of the 46 Pu-island assembly reload introduced in the Garigliano reactors in 1975 and of a batch of 8 all Pu assemblies loaded in the Trino Vercellese PWR in 1976. Subsequently, the experimental activities planned for the near future both on high burn-up prototypes and on industrial fuel after one cycle of operation are examined.

41321 (ORNL/NUREG/TM—97) **Noise diagnostics for safety assessment. Quarterly progress report for October—December 1976.** Booth, R.S. (Oak Ridge National Lab., Tenn. (USA)). 26 Jan 1977. Contract W-7405-ENG-26;NRC-INA-40-551-75;NRC-INA-40-552-75. 10p. Dep. NTIS, PC A02/MF A01.

The scope of this new confirmatory assessment program includes neutron noise diagnostics, core internal vibration monitoring, loose-parts monitoring, and plant surveillance using noise diagnostic techniques. Accomplishments thus far include: (1) obtaining neutron noise signatures from the Browns Ferry Nuclear Plant to aid in assessing monitoring techniques for in-core instrument tube vibrations, (2) initiating review of loose-parts monitoring systems, and (3) initiating review of analytical and experimental tools being applied by industry to detect and determine the cause of vibrations in rotating machinery such as pumps, motors, and turbines.

41322 (SIGLUT-P—719) **Feed and condensate pumps in nuclear power stations.** Sturzinger, C. (Sigma, Lutin (Czechoslovakia)). 27 Sep 1974. 13p. (In Czech). Dep. NTIS (US Sales Only), PC A02/MF A01.

Translated from Combustion (1973) v. 45(2) p. 6-14. Available from Sigma, Lutin, Czechoslovakia.

Approximately 80% of electric power of nuclear power plants which are currently in operation or under construction goes to light water reactor plants in their two variants: the BWR and the PWR. The problems are analysed of the design, materials used, operation, and operational testing of feed and condensate pumps for these systems. The operating requirements and specific data on pumps manufactured by the Sulzer company are stated.

41323 **Nuclear off-gas treatment...the cryogenic distillation method.** Rello, R.M. (Air Prod and Chem Inc, Allentown, Pa). *Instrum. Technol.;* **22**: No. 5, 45-49(May 1975).

Instrumentation for the cryogenic distillation method of treating off-gas from a BWR nuclear power plant is described. A review of control valve reliability and leakage tests is presented. The design and testing of monitor and control analyzers to ensure process safety are considered, along with the seismic requirements applicable to all the instrumentation.

41324 **Development of an integrated prestressed concrete vessel for water cooled reactors.** Jueptner, G.; Kumpf, H.; Molz, G.; Neunert, B.; Seidl, O. Munich; Dycherhoff and Widmann (1976). 118p. (In German with English abstract).

Design criteria are given for selecting a star-like vessel configuration for accommodating a complete primary circuit including a pressure water power reactor of e.g. 1,300 MW effective capacity, this involving the grouping of cylindrical pressure vessels of independent design into a star-shaped configuration with the central

vessel housing the reactor core in the middle. A detailed description is given of the prestressed concrete pressure vessel, the support boiler and the cover used in the center vessel. 20 refs.

41325 Thin-film evaporators for processing BWR liquid radwaste. Rupinskas, R.L.; Vogt, P.M. (Sargent and Lundy, Chicago, Ill). *Am. Soc. Mech. Eng.*, [*Pap.*]; No. 76-WA/NE-4, 1-9(5 Dec 1976).

The motion of the rotor and the agitation produced provide the thin-film (mechanically aided) evaporator with the capability of overcoming certain limitations of conventional methods of evaporation. Tests and some operating experience indicate that the thin-film evaporator can effectively concentrate sodium sulfate waste, laundry waste, and floor drain waste for a nuclear (Boiling Water Reactor--BWR) power plant. Use of a thin-film evaporator for complementing a conventional evaporator is economically justified by a reduction in solidification and disposal costs caused by decreasing the volume of waste requiring solidification.

41326 Role of volume reduction processes in LWR radwaste treatment. Kniazewycz, B.G. (TERA Corp, Berkeley, Calif). *Am. Soc. Mech. Eng.*, [*Pap.*]; No. 76-WA/NE-5, 1-11(5 Dec 1976).

In current LWR technology large quantities of radioactive or potentially radioactive waste are generated due to the formation and release of corrosion and fission products to the process fluids. From the earliest stages of LWR development various means of reducing the volume of radwaste have been developing - filtration, demineralization, evaporation, and recently membrane technology. These treatment techniques have produced manageable quantities of sludges, spent resin, and evaporator bottoms from early generation plants. However, with the inception of large multi-unit facilities, change in regulatory criteria, and the large increase in capital and operating costs, additional emphasis on the economics of radwaste treatment is required. A review of the economics of radwaste management from waste inception to final disposal and burial is presented with emphasis on the necessity of an integrated design philosophy. 10 refs.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

REFER ALSO TO CITATION(S) 41312, 41315, 41316, 41317, 41318, 41319, 41320, 41321, 41322, 41324, 41326, 41432, 41451, 41490, 41491, 41492, 41497, 41515, 41516, 41520, 41523, 41524, 41525, 41526, 41530, 41531, 41534, 41536, 41544, 41545, 41553, 41555

41327 (CEA-R—4798) **Irradiation temperature memorization bt retention of krypton-85. Application to the temperature determination for the internal cladding surface of fuel elements in PWR.** Fremiot, C. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Technologie; Paris-6 Univ., 75 (France)). Jan 1977. 139p. (In French). Dep. NTIS (US Sales Only), PC A07/MF A01.

Thesis.

The temperature of the inner surface of the cladding fuel elements, which can not be measured directly, can be determined after irradiation. During its stage within the reactor, the cladding is bombarded by krypton-85 fission product, which is trapped in the metallic lattice defects. The experience shows that the krypton release during postirradiation heating takes place at the irradiation temperature. This method was applied for PWR fuel element. A very simple model for retention and release of the krypton is proposed. The krypton trap-energy in zircaloy partakes in this model. It is pointed out that the principal interest in that method is the fact that it does not need any fuel element instrumentation. At the present, this method is being used by CEA for routine-control.

41328 (CONF-770401—3) **Three-dimensional synthesis approach to reactor internal gamma-ray heating.** West, J.T. III, Whitmarsh, C.L. (Babcock and Wilcox Co., Lynchburg, Va. (USA)). 1977. Contract W-7405-ENG-26. 7p. Dep. NTIS, PC A02/MF A01.

From 5. international conference on reactor shielding; Knoxville, Tennessee, United States of America (USA) (18 Apr 1977).

The construction of a unique procedure for generating a three-dimensional gamma heating data base has been completed for a PWR reactor design. The data base construction is achieved by the development of synthesizing equations combining several ANISN gamma heating results with several DOT gamma heating results. These three-dimensional equations contain appropriate corrections for particle streaming and scattering effects. This presents a new approach to the problem of three-dimensional data generation and efficient data transfer between radiation transport codes and thermal stress codes.

41329 (CONF-770401—4) **Evaluation of uncertainties in the gamma-ray heating analysis of a PWR.** West, J.T. (Babcock and Wilcox Co., Lynchburg, Va. (USA)). 1977. Contract W-7405-ENG-26. 9p. Dep. NTIS, PC A02/MF A01.

From 5. international conference on reactor shielding; Knoxville, Tennessee, United States of America (USA) (18 Apr 1977).

The limits of accuracy in a PWR gamma heating analysis, which used conventional one- and two-dimensional discrete ordinate transport methods, by utilizing three-dimensional Monte Carlo methods are determined.

41330 (CS-INIS—3) **How nuclear welding differs from other kinds.** Blaisdell, R.E. (Prvni Brnenska Strojirna (Czechoslovakia)). [nd]. 11p. (In Czech). (P—5324). Dep. NTIS (US Sales Only), PC A02/MF A01.

Translated from Weld. Des. Fabr. (Sep 1973), p. 45-48. Available from Prvni Brnenska Strojirna, odbor TEI, Brno, Czechoslovakia.

Permissible deviations are explained from the IIIrd and IXth ASME codes related to the qualification of welding techniques for the manufacture of nuclear installations. Examples of the application of certain provisions for PWR reactors are given.

41331 (IAEA-CN—36/310) **Italian progress on LWR fuel design, manufacturing, testing and management.** Arcelli, G.; Ariemma, A; Cometto, M.; Paoletti Gualandi, M.; Bozzoni, T.; Coluccio, G.; Gabaglio, M.; Pistella, F.; Gatti, S.; Gerevini, T. (International Atomic Energy Agency, Vienna (Austria)). 1977. 10p. (In French). (CONF-770505—161). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.4.-.T.1./03.

This paper summarizes the main activities carried out in Italy from the last Geneva Conference (1971) in the field of LWR fuel design, manufacturing, testing and management. In fuel design, large effort has been devoted both to the assimilation of the information resulting from the licensing agreement with the US suppliers and to the development of an independent know-how through adequate R and D programs as well as to fuel behavior modeling activities. Among these it is worthwhile to mention the studies carried out by CNEN on the in-pile behavior of gadolinia fuel rods, the critical heat flux (CHF) and void fraction experiments, the overpower ramp tests on pre-irradiated fuel rods, the measurements of the pellet-cladding thermal conductance vs. burn-up and the investigation on fission gas release kinetics. The experience acquired with the fuel of the two LWR ENEL power stations, Garigliano BWR and Trino PWR, and some fuel management problems are reviewed. In this framework mention is made to the effort devoted to the acquisition of a wider knowledge on fuel behavior through post irradiation examination (PIE) of power reactor fuel elements as well as of experimental rods. The Italian fuel manufacturing capabilities are illustrated: they consist of the FN (Fabbricazioni Nucleari) plant at Bosco Marengo, owned by AGIP Nucleare and AMN, which has produced up-to-now a reload for Garigliano BWR and the first core for Caorso BWR and of COREN (COmbustibili REattori Nucleari) at Saluggia, owned by Breda, FIAT and Westinghouse, which has fabricated reloads for Trino PWR, including 8 UO_2-PuO_2 fuel bundles, while fuel loading for the Otto Hahn nuclear ship and fuel mechanical components for some PWRs have been fabricated by FIAT.

41332 (IAEA-CN—36/537) **Experience of NPS construction in the People's Republic of Bulgaria.** Kostadinov, K.; Ruskov, S. (International Atomic Energy Agency, Vienna (Austria)). 1977. 10p. (In Russian). (CONF-770505—166). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

7.3.-.T.1./01.

The paper summarizes the experience gained during the construction of the first NPS in the People's Republic of Bulgaria. The present state and prognoses for the development of electrical energy and particularly of nuclear energy in the People's Republic of Bulgaria are given in the paper. The authors underline the investigations carried out for the choice of the reactor type, site selection and some specific moments of designing, construction, assembly and physical and power start-up of the NPS "Kozlodui", as well as the experience of the first period of the NPS operation. There are also reflected questions of staff-training for NPS construction and operation in the People's Republic of Bulgaria and the trend of a scientific and research work for a more reasonable NPS construction and operation.

41333 (IAEA-CN—36/568) **Medium-size nuclear plants.** Vogelweith, L.; Lavergne, J.C.; Martinot, G.; Weiss, A. (International Atomic Energy Agency, Vienna (Austria)). 1977. 9p. (In French). (CONF-770505—206). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

7.2.-.T.1./03 1 table, 7 figs.

CEA (TECHNICATOME) has developed a range of pressurized water reactors of the type "CAS compact" which are

adapted to civil ship propulsion or to electric power production, combined possibly with heat production, up to outputs equivalent to 125 MWe. Nuclear plants equipped with these reactors are suitable for medium-size electric networks. Among the possible realizations, two types of plants are mentioned as examples: 1) Floating electronnuclear plants; and 2) Combined electric power and desalting plants. The report describes the design characteristics of the different parts of a 125 MWe unit floating electronuclear plant: nuclear steam system CAS 3 G, power generating plant, floating platform for the whole plant. The report gives attention to the different possibilities according to site conditions (the plant can be kept floating, in a natural or artificial basin, it can be put aground, ...) and to safety and environment factors. Such unit can be used in places where there is a growing demand in electric power and fresh water. The report describes how the reactor, the power generating plant and multiflash distillation units of an electric power-desalting plant can be combined: choice of the ratio water output/electric power output, thermal cycle combination, choice of the gain ratio, according to economic considerations, and to desired goal of water output. The report analyses also some technical options, such as: choice of the extraction point of steam used as heat supply of the desalting station (bleeding a condensation turbine, or recovering steam at the exhaust of a backpressure turbine), design making the system safe. Lastly, economic considerations are dealt with: combining the production of fresh water and electric power provides usually a much better energy balance and a lower cost for both products. Examples are given of some types of installations which combine medium-size reactors with fresh water stations yielding from 10000 to 120000 m^3 per day.

41334 (IAEA-CN—36/569) **Work carried out in France on the design, manufacture, handling and development of nuclear fuel.** Brandt, R.C.; Joly, G.; Gloaguen, A.; Traccucci, R.; Delafosse, J. (International Atomic Energy Agency, Vienna (Austria)). 1977. 9p. (In French). (CONF-770505—164). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.4.-.T.1./10 Also available in English.

Although the ordinary water reactors to be found in France all belong to the PWR type, the fuel used covers a broad range: box assemblies with steel canning at the SENA plant, 15x15 at TI-HANGE, 17x17 for 900 MW phases, slug and plate fuel developed by the Atomic Energy Commission and extra-long 17x17 for 1300 MW phases, also being developed. A description of what France is undertaking today with respect to: 1) design; 2) manufacture; 3) management; and 4) development of fuel assemblies is presented.

41335 (INIS-mf—3389, pp 31-45) **In-service inspection of life and reliability of pipe system of WWER 1000 primary circuit.** Lebl, P. (Sigma, Prague (Czechoslovakia). Vyzkumny Ustav Cerpacich Zarizeni, Potrubi a Armatur). 1974. (In Czech).

In In-service inspection and diagnostics of nuclear power installations. Part 1.

The main experience and results are summarized of control experimental tests carried out in the period of commissioning and during the complex tests on the conduit of the primary coolant circuit of the A-1 nuclear power plant. On the basis of these experiments the method was drawn up of experimental in-service life and reliability inspection of the WWER-1000 primary circuit conduit. A set of measurement parameters and a model of processing experimental information are suggested.

41336 (INIS-mf—3389, pp 46-51) **Quality assurance of production of steam generators and volume compensators for WWER-440 type nuclear power plants.** Magera, M. (Vitkovicke Zelezarny Klementa Gottwalda, Ostrava (Czechoslovakia)). 1974. (In Czech).

In In-service inspection and diagnostics of nuclear power installations. Part 1.

Experience is summed up with the manufacture of reactor pressure vessels for the A-1 nuclear power plant and conclusions are drawn for the manufacture of the individual components of WWER-440 nuclear power plants. Demands on production enterprises are formulated for the manufacture and delivery of steam generators and pressurizers and the production preparedness of these enterprises is assessed. A survey is given of various types of prescribed control and trial operations.

41337 **Nuclear power plant at Biblis.** Alertmann, B.; Delagare, F. *Energie;* **27**: No. 4, 95-105(Apr 1975). (In German).

Design data and description of the equipment used for the first stage of the power plant, located in West Germany are given. Block A, with installed power of 1,146 MVA, has been put into operation. 9 refs.

41338 **Nuclear power plant of Tihange.** Cabanius, J.; Nihoul, P. (SEMO, Fr). *Travaux;* No. 482, 23-31(May 1975). (In French).

A detailed and graphically documented review of construction, facilities, technical characteristics, and operation is presented.

41339 **Prestressed concrete pressure vessel with hot liner for PWR nuclear reactors.** Jungmann, A.; Kopp, H.; Gangl, M.; Nemet, J.; Nesitka, A.; Mutzl, J. Erlangen, Ger.; Kraftwerk Union (1976). 58p. (In German).

Design concept of heat-resisting steel liner inside a prestressed concrete pressure vessel is described. Test results conducted on a model are given. Stress analysis and creep behavior of concrete are calculated. A comparison of costs is made with other types of pressure vessels. It is demonstrated with respect to design and calculation that in accordance with the concept chosen, a prestressed concrete vessel employed as a reactor pressure vessel can be used for pressurized water reactors. 34 refs.

41340 **Representation of the light-water reflectors by boundary conditions.** Kalambokas, P.C.; Henry, A.F. (MIT, Cambridge, Mass). *Nucl. Sci. Eng.;* **61**: No. 2, 181-194(Oct 1976).

A general relationship between two-group fluxes and normal currents on the surface of a core surrounded by a homogeneous reflector is derived. The relationship is an integral one derived directly from the group diffusion equations for the homogeneous reflector material and hence depending only on group parameters associated with the reflector material. Approximate homogeneous, algebraic boundary conditions relating group fluxes to group currents at the core-reflector interface are then derived, and these are applied to three sizes of pressurized water reactors (PWRs). Application to a large PWR at the interface between core shroud and reflector yields particularly excellent results for criticality and flux shapes in the core. The savings in computer running time over that required if the reflector is accounted for explicitly is about 40%.

41341 **Nonlinear dynamics of a pressurized water reactor core.** Onega, R.J.; Karcher, K.E. (Va Polytech Inst and State Univ, Blacksburg). *Nucl. Sci. Eng.;* **61**: No. 2, 276-282(Oct 1976).

A nonlinear mathematical model for determining the dynamic response of a pressurized water reactor was developed that incorporates both prompt and delayed temperature feedback. The use of a modified form of Hansen's method of largest eigenvalues was employed to obtain the solution. The novel features of this model are that th nonlinearities are treated explicitly, and the temperature dependence of thermal-hydraulic parameters is preserved without approximation. A comparison of power and temperature transients was made with other work.

41342 **Functional performance of a two-tube helically-coiled once-through steam generator.** Carter, H.R.; Watson, G.B.; Johnson, L.E. (Babcock and Wilcox Co, Res and Dev Div, Alliance, Ohio). *Am. Soc. Mech. Eng., [Pap.];* No. 76-WA/HT-69, 1-9(5 Dec 1976).

A two-tube once-through helically coiled steam generator was tested at pressurized water reactor (PWR) conditions. Specific items studied included: overall functional performance, isothermal friction factors, single- and two-phase pressure drop, and single- and two-phase heat transfer. The two-tube steam generator was constructed using 19-mm O.D. Alloy 600 tubes with helix diameters of 2.34 and 3.82m. Superheated steam was produced at all expected operating conditions. Pressure drop for both single- and two-phase conditions was higher than that of a geometrically similar straight tube; however, good agreement was obtained between observed and predicted results by correcting for tube curvature effects. Heat transfer coefficients for single-phase forced convection were in agreement with results predicted using conventional straight tube correlations. However, local overall boiling heat transfer coefficients were higher than predicted using existing correlations. 15 refs.

41343 **Modeling the effect of inventory loss on steam generator heat transfer.** Land, R.E.; Steitler, R.W. (Westinghouse Electr Co, Pittsburgh, Pa). *Am. Soc. Mech. Eng., [Pap.];* No. 76-WA/HT-70, 1-5(5 Dec 1976).

A problem in the computer modeling of pressurized water reactor system transients is the inability to easily define the heat transfer characteristics of steam generators in situations when the fluid inventory is decreased to the point where degradation of the tube bundle heat transfer coefficients occur. A detailed heat transfer model is discussed as well as a simple, but accurate, model used to determine transient steam generator response.

41344 **Prediction of pump differential pressure for two-phase/two-component compressible flow.** Muench, R.A. (Westinghouse Electr Corp, Pittsburgh, Pa). *Am. Soc. Mech. Eng., [Pap.];* No. 76-WA/HT-75, 1-7(5 Dec 1976).

The paper first describes the use of the energy equation to define pump head in a way that is acceptable for two-phase flow. The method of solution of the energy equation without knowing the thermodynamic state of the discharge flow is then presented. With the definition of pump head, two-phase test data on a particular pump are reduced. This test data along with the theory that a pump is a volumetric flow machine, is used to demonstrate the use of an equivalent density to link incompressible pump performance. The tendencies of the two-phase data relative to pump speed and flow and pump inlet thermodynamic conditions are investigated and a possible correlation is provided. 7 refs.

41345 PWR secondary system chemistry during air and cooling water in leakage. Sawochka, S.G.; Pearl, W.L.; Pham, H.T. (Nucl Water and Waste Technol, San Jose, Calif). *Am. Soc. Mech. Eng.*, [*Pap.*]; No. 76-WA/NE-14, 1-5(5 Dec 1976).

Preliminary results of a two-year, five-plant study on PWR secondary water chemistry funded by the Electric Power Research Institute are reviewed relative to the effects of air and cooling water inleakage. Results are presented on the effects of inleakage on bulk water chemistry at several operating plants. Solution chemistry in locations where evaporation and concentration occur also is discussed.

41346 Fuel performance in Babcock and Wilcox pressurized water reactors. Tulenko, J.S.; Spaziani, J.C.; Mayer, J.T. (Babcock and Wilcox Co, Lynchburg, Va). *Am. Soc. Mech. Eng.*, [*Pap.*]; No. 76-WA/NE-16, 1-8(5 Dec 1976).

Operational performance of Babcock and Wilcox fuel is evaluated by two methods, primary coolant radiochemistry analysis and an extensive fuel inspection and measurement program. Current iodine-131 levels at the six operating plants indicate a fuel integrity of greater than 99.995 percent (less than 0.005 percent leaking fuel). Two of the six have iodine levels consistent with zero defects. Post-irradiation examination of fuel through the end of two cycles at Oconee I shows the fuel to be in excellent condition. Rod bow is quite small, with 95 percent of all fuel rods exhibiting a gap closure of 20 percent or less. Destructive and nondestructive test data on fuel densification show good agreement with model predictions. Additional data on fuel assembly parameters show the fuel to be operating within design criteria.

41347 Radiochemical evaluation of Babcock and Wilcox's commercial pressurized water reactor fuel performance. Chulick, E.T.; McDaniel, T.L. (Babcock and Wilcox Co, Lynchburg, Va). *Am. Soc. Mech. Eng.*, [*Pap.*]; No. 76-WA/NE-19, 1-8(5 Dec 1976).

An equilibrium radiochemistry model and a computer code calculation are used for the radiochemical evaluation of PWr fuel performance. The equilibrium model presupposes a static environment and when those conditions prevail, it can be used to determine the fraction of fuel releasing activity to the reactor coolant. The computer code utilizes the dynamic parameters of an operating PWR and allows flexibility in input and output. The code can calculate defective fuel levels and determine the dependence of those levels on input parameters. The code can also be used in the predictive mode to estimate coolant levels in the future based on the PWR operating history.

41348 Radwaste treatment study for a once through steam generator cleaning solution. Ferrigno, D.P.; Montgomery, C.R. (Gilbert/Commonw Co, Reading, Pa). *Am. Soc. Mech. Eng.*, [*Pap.*]; No. 76-WA/NE-6, 1-7(5 Dec 1976).

The paper reviews the various methods available for the treatment and disposal of the spent radioactive cleaning solution produced in cleaning the secondary side of the once-through steam generators at Three Mile Island Nuclear Fueled Power Generating Station following operation with primary to secondary leakage. Normally, the spent, nonradioactive cleaning solution will be disposed of by incineration in a fossil boiler. In the paper, each disposal method for a radioactive spent solution is evaluated for its technical merit and economic soundness. The conclusion is that standard equipment can meet the need of the industry to safely concentrate and package the spent, radioactive cleaning solution for offsite burial.

41349 Fault tolerant, multiplexed control rod position detection and indication system for nuclear power plants. Dufek, W.L.; Jelovich, J.J.; Neuner, J.A. (Westinghouse Electr Corp, Baltimore, Md). *Am. Soc. Mech. Eng.*, [*Pap.*]; No. 76-WA/NE-7, 1-8(5 Dec 1976).

The paper describes a new digital control rod position indication system (DRPI) developed for use in pressurized water reactors. It includes the detectors, data processing electronics, a dedicated control room display, and interface to the plant computer and annunciator systems. The system is compatible with existing and future Westinghouse reactors, since it satisfies strict environmental and physical envelope requirements imposed on an earlier generation analog system. However, it provides increased stability and tolerance of mechanical and environmental variations.

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

REFER ALSO TO CITATION(S) 41452, 41528

41350 (COO—2975-3) **Advanced gas cooled nuclear reactor materials evaluation and development program. Progress report, September 23, 1976—December 31, 1976.** (General Electric Co., Schenectady, N.Y. (USA)). Jan 1977. Contract EY-76-C-02-2975.A002. 41p. Dep. NTIS, PC A03/MF A01.

This report presents the results of work performed from September 23, 1976 through December 31, 1976 on the Advanced Gas Cooled Nuclear Reactor Materials Evaluation and Development Program. The objectives of this program are to evaluate candidate alloys for Very High Temperature Reactor (VHTR) Process Heat and Direct Cycle Helium Turbine (DCHT) applications, in terms of the affect of simulated reactor primary coolant (impure Helium), high temperatures, and long time exposures, on the mechanical properties and structural and surface stability of selected candidate alloys. A second objective is to select and recommend materials for future test facilities and more extensive qualification programs. Work covered in this report includes progress to date on alloy selection for VHTR Nuclear Process Heat (NPH) applications and for DCHT applications. The present status on the simulated reactor helium loop design and on designs for the testing and analysis facilities and equipment is discussed.

41351 (CRBRP-ARD—0106(Vol.2)) **Clinch River Breeder Reactor Plant. Appendix A. Flow diagram for the VARR II program.** Cook, J.L.; Nakayama, P.I. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Nov 1976. Contract E(49-18)-12-3;E(11-1)-2395. 72p. AT.

41352 (DEU—76-38) **Directors' report, 1975.** (Hochtemperatur-Kernkraftwerk G.m.b.H. (HKG), Uentrop (Germany, F.R.)). 1976. 22p. (In German). Dep. NTIS (US Sales Only), PC A02/MF A01.

With figs. Available from ZAED.

The present directors' report contains the daily report of the regular associates meeting held on 14.9.76, the management's report, the balance of 31.12.1975, and the test report. In the managers' report stress is laid upon the THTR-300 which is being constructed.

41353 (GA-A—14007) **Evaluation of Fort St. Vrain nuclear analysis methods.** Marshall, A.C.; Hamilton, C.J. (General Atomic Co., San Diego, Calif. (USA)). Feb 1977. Contract EY-76-C-03-0167-017. 80p. Dep. NTIS, PC A05/MF A01.

The methods used for the nuclear analysis of the Fort St. Vrain (FSV) HTGR are described. An evaluation of these methods is made by comparing their results with measurements made during the zero- and low-power (up to 2 percent) start-up tests. This evaluation shows reasonably good agreement of the results of the models with the measurements for both axial flux distributions and radial peaking factors. In particular, the study shows that the GAUGE code, a fast, two-dimensional, one-thermal-group, diffusion-theory code routinely used for HTGR nuclear design calculations, gives acceptable agreement with the available measurements.

41354 (GA-A—14049) **Investigation into the causes and consequences of the malfunction of static shutdown seal S/N 3 in Fort St. Vrain circulator C2102 from the "D" penetration.** (General Atomic Co., San Diego, Calif. (USA)). 30 Sep 1976. Contract EY-76-C-03-0633. 88p. Dep. NTIS, PC A05/MF A01.

The helium circulators for the Fort St. Vrain nuclear power station incorporate bellows-actuated shutdown seals. Circulator C2102 was removed in March 1976 from its penetration following a suspected failure of the bellows actuator or its supply line, as evidenced by a substantial leak. The circulator was returned to San Diego for disassembly and inspection. Examination of the shutdown seal revealed the failure to be a circumferential crack in the inner bellows in the crown of the first convolution adjacent to the fixed end. Investigation of the failure showed that the crack was most probably initiated by repeated overextension of the bellows prior to installation in the circulator and was propagated by shorter stroke cyclic loading. It was concluded that the conditions leading to failure were abnormal and unique to this particular seal and circulator. Therefore, the failure does not appear to be indicative of a generic problem.

41355 (GA-A—14298) **HTGR fuels and core development program. Quarterly progress report for the period ending February 28, 1977.** (General Atomic Co., San Diego, Calif. (USA)). Mar 1977. Contract EY-76-C-03-0167-017. vp. Dep. NTIS, PC A12/MF A01.

The work reported includes studies of reactions between core materials and coolant impurities, basic fission product transport mechanisms, core graphite development and testing, and development and testing of recyclable fuel systems, and physics and fuel management studies. Materials studies include irradiation capsule tests of both fuel and graphite.

41356 (IAEA-CN—36/94) **Gas-cooled high temperature reactor: perspectives, problems and programmes.** Beckurts, K.H.; Engelmann, P.; Erb, D.E. (International Atomic Energy Agency, Vienna (Austria)). 1977. 13p. (CONF-770505—170). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

1.C.-.P.1./06 1 table, 2 figs.

For nearly 20 years, extensive research and development programs on Helium-cooled high-temperature reactors (HTR) have

been carried out in several countries of the world, in particular in Germany and in the United States. This reactor system offers major potential advantages as a source of electricity or of nuclear process heat: it shows high nuclear fuel conversion efficiency, permitting a better utilization of uranium and in particular of thorium resources; it offers a high degree of inherent nuclear safety and thus a good potential for adoption to very strict safety standards; it permits high-efficiency electricity generation using either the indirect steam or the direct Helium cycle; dry air cooling can be employed without major economic penalties; it permits direct use of the nuclear heat for the production of gaseous or liquid secondary fuels from coal and other fossil fuels or - on a more extended time scale - by thermochemical water splitting. As a result of the longstanding efforts, satisfactory solutions have been found for many of the basic problems of this new reactor system, particularly in the field of high-temperature fuels and materials technology. Three small experimental plants - Peach Bottom in USA, Dragon in England, and AVR in Germany - have been operated successfully over extended periods of time. The AVR is still in operation; since 1974 it has performed satisfactorily with an average gas outlet temperature of 950°C. Prototype steam-cycle plants of 300 MW(e) are underway at Fort St. Vrain, USA (full-power operation scheduled for 1977), and at Schmehausen, Germany (scheduled for 1979). Major delays have occured in the construction and commissioning of these plants; they are due to various reasons and do not reveal specific problems of the HTR. Commercial market introduction of the steam-cycle electricity generating system has been attempted, but the first approach has not been successfull.

41357 (IAEA-CN—36/168) **Present status of fuel researches for VHTR in Japan.** Nomura, S.; Iwamoto, K.; Tsujino, T. (International Atomic Energy Agency, Vienna (Austria)). 1977. 7p. (CONF-770505—143). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.6.-.T.1./03 2 tables, 5 figs.

Studies of fuel and its reprocessing studies are in progress along the experimental VHTR program aiming at 1000°C He outlet temperature and 50MWt output. Pin-in-block type fuels containing low enriched UO_2 TRISO-coated particles will be used in the VHTR. Fabrication studies of the particles and the fuel compacts have been carried out. Capsule irradiation of the fuel specimens are being done mostly in JMTR; the highest temperature and burnup attained so far are 1300°C and 20,000 MWD/T, respectively. The installation of OGL-1 inpile gas loop in JMTR (JAERI) is near completion and in 1977 a fuel element containing three fuel rods is expected to be irradiated at max. 1400°C in He gas of 30 atm. and 1000°C outlet temperature. The other works include irradiation and corrosion experiments on graphite, and coolant flow and heat transfer experiments on dummy fuel elements using a high temperature, high pressure out-of-pile He gas loop. Fabrication and irradiation tests of ZrC-coating on fuel particles are also in progress. Process studies have been commenced on head-end step in the reprocessing of VHTR fuel. Some advanced process concept including graphite gasification with off-gas recycle, jet breakage of the particles and volatile f.p.'s removal is proposed to solve such technical problems as complex mechanical operation and surplus environmental discharge of ^{14}C. The concept is framed based upon the experiences obtained by the fluoride volatility studies for the reprocessing of LMFBR fuels.

41358 (IAEA-CN—36/325) **Nuclear steam superheat results and current prospects.** Baturov, B.B.; Zvereva, G.A.; Mityaev, Yu.I.; Mikhan, V.I. (International Atomic Energy Agency, Vienna (Austria)). 1977. 12p. (In Russian). (CONF-770505—169). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

8.0.-.T.1./10 1 table, 5 figs. Also available in English.

Experience gained from prolonged operation of superheating channel of Beloyarsk nuclear power station has convincingly proved engineering feasibility of efficient nuclear superheat. The problems of ensuring both the necessary relation between the power for evaporation and for steam superheating and the safety of channel transfer from water to steam cooling in channel-type reactors are solved relatively easy. Channels in operation with steam outlet temperature up to 565°C have proved great operational reliability at the burnup up to 35 kg/t and with normal service life of six-seven years. These results allow counting on good economics of the nuclear power station in spite of relatively great quantity of steel and neutron absorbing contact materials of fuel composition. The use of superheating channels with fuel rods in which the quantity of steel per unit mass of uranium is reduced and the contact material is eliminated allows improving operating and economic characteristics of channel-type reactor by implementing nuclear superheating of steam in it. The report sums up the results of the Beloyarsk nuclear power station operation and examines the prospects of nuclear superheat on the example of the large modular reactor RBM-KP. The project of this type of reactor has fully solved the problems of this trend in nuclear power engineering which is important from a viewpoint of uranium savings and essential reduction of heat removal.

41359 (IAEA-CN—36/578) **HTGR fuel and fuel cycle technology.** Lotts, A.L.; Homan, F.J.; Balthesen, E.; Turner, R.F. (International Atomic Energy Agency, Vienna (Austria)). 1977. 12p. (CONF-770505—172). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.6.-.T.1./02 4 tables, 5 figs.

Significant advances have occurred in the development of HTGR fuel and fuel cycle. These accomplishments permit a wide choice of fuel designs, reactor concepts, and fuel cycles. Fuels capable of providing helium outlet temperatures of 750°C are available, and fuels capable of 1000°C outlet temperatures may be expected from extension of present technology. Fuels have been developed for two basic HTGR designs, one using a spherical (pebble bed) element and the other a prismatic element. Within each concept a number of variations of geometry, fuel composition, and structural materials are permitted. Potential fuel cycles include both low-enriched and high-enriched Th-^{235}U, recycle Th-^{233}U, and Th-Pu or U-Pu cycles. This flexibility offered by the HTGR is of great practical benefit considering the rapidly changing economics of power production. The inflation of ore prices has increased optimum conversion ratios, and increased the necessity of fuel recycle at an early date. Fuel element makeup is very similar for prismatic and spherical designs. Both use spherical fissile and fertile particles coated with combinations of pyrolytic carbon and silicon carbide. Both use carbonaceous binder materials, and graphite as the structural material. Weak-acid resin (WAR) UO_2-UC_2 fissile fuels and sol-gel-derived ThO_2 fertile fuels have been selected for the Th-^{233}U cycle in the prismatic design. Sol-gel-derived UO_2UC_2 is the reference fissile fuel for the low-enriched pebble bed design. Both the United States and Federal Republic of Germany are developing technology for fuel cycle operations including fabrication, reprocessing, refabrication, and waste handling. Feasibility of basic processes has been established and designs developed for full-scale equipment. Fuel and fuel cycle technology provide the basis for a broad range of applications of the HTGR.

41360 (IAEA-CN—36/586) **Uranium-graphite reactor development in the USSR.** Aleksandrov, A.P.; Dollezhal, N.A. (International Atomic Energy Agency, Vienna (Austria)). 1977. 16p. (In Russian). (CONF-770505—168). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

1.C.-.P.1./05 Also available in English.

The paper analyzes design experience and development prospects of graphite-moderated channel power reactors, which represent one of the main lines of nuclear power activity in the Soviet Union. The characteristics of these reactors are described and discussed, and data are presented to show that their power can be increased to 1.5 million kW and more. The authors consider some technical solutions which would ensure the reliability and safety of such reactors, at higher power, and describe those adopted for the projected 2.4 million kW channel reactor in sectional block design with nuclear steam superheat. The prospects for further growth of unit capacities and improvement of the technical and economic characteristics of these reactors are discussed.

41361 (ORNL/TM—5552) **Uranium loss from BISO-coated weak-acid-resin HTGR fuel.** Pearson, R.L.; Lindemer, T.B. (Oak Ridge National Lab., Tenn. (USA)). Feb 1977. Contract W-7405-ENG-26. 27p. Dep. NTIS, PC A03/MF A01.

Recycle fuel for the High-Temperature Gas-Cooled Reactor (HTGR) contains a weak-acid-resin (WAR) kernel, which consists of a mixture of UC_2, UO_2, and free carbon. At 1900°C, BISO-coated WAR UC_2 or UC_2-UO_2 kernels lose a significant portion of their uranium in several hundred hours. The UC_2 decomposes and uranium diffuses through the pyrolytic coating. The rate of escape of the uranium is dependent on the temperature and the surface area of the UC_2, but not on a temperature gradient. The apparent activation energy for uranium loss, ΔH, is approximately 90 kcal/mole. Calculations indicate that uranium loss from the kernel would be insignificant under conditions to be expected in an HTGR.

41362 (PB—258150) **Significant actinide and daughter activities from the HTGR fuel cycle.** Simmons, G.L.; Gritzner, M.L. (Environmental Protection Agency, Washington, D.C. (USA)). Sep 1975. 114p. (EPA—520/3-76/011). NTIS $5.50.

The report presents tables and graphs of transuramic actinide fission product activity from the high temperature gas reactor nuclear fuel cycle. (GRA)

41363 Inelastic analysis of tubesheets by the finite element method. Pai, D.H.; Hsu, M.B. (Foster Wheeler Energy Corp, Livingston, NJ). *Am. Soc. Mech. Eng., [Pap.]*; No. 75-PVP-57, vp(1975).

A procedure of inelastic (plastic and creep) analysis of tubesheets using a two-dimensional finite element approach is described. Essentially, the approach is one of extending the equivalent plate concept used in elastic analysis into the plastic and creep ranges. The behavior of the perforated region is first characterized by means of analytical experiments performed on a typical portion of a ligament. Once this is done, a formal axisymmetric finite element analysis is performed treating the perforated region as a dissimilar but homogeneous material. Results of recent analysis of a superheater tubesheet in support of an HTGR steam generator design development is presented. Additional planned design development and experimental verification are also discussed. 8 refs.

41364 Eigenvalue sensitivity study of a high temperature gas cooled reactor system. Greenlee, T.L. pp 434-435 of In Proceedings of the 14th conference of the Institute of Electrical and Electronics Engineers. New York; IEEE (1975).

From 14th IEEE conference; Houston, TX, USA (10 Dec 1975).

This paper discusses the application of an eigenvalue sensitivity method to a linear, time-invariant, model of the High-Temperature Gas-Cooled Reactor (HTGR) manufactured by General Atomic. It is shown that for this type of system with distinct eigenvalues, a relation can be obtained between the solutions to the classical sensitivity equation and the eigenvalue and eigenvector sensitivities. This relation indicates that the eigenvalue and eigenvector sensitivities are more fundamental indicators of parametric effects than the solutions of the sensitivity equation. A FORTRAN Program (SENSIT) was developed to implement the algorithms required for eigenvalue sensitivity calculations. This program was applied to a large scale (58 state) linear time invariant model of the HTGR operating under closed loop control.

41365 Feedwater chemistry requirements for HTGR steam generator operation. Schuetzenduebel, W.G.; Eisenhofer, J.J. (Gen At Co, San Diego, Calif). *Am. Soc. Mech. Eng., [Pap.]*; No. 76-WA/NE-13, 1-11(5 Dec 1976).

Stringent feedwater chemistry control is required for once-through steam generators in HTGR nuclear steam supply systems. The reasons for such requirements and the effects of deviations from these established limits due to various possible system defects or malfunctions, such as condenser leakage or polishing system problems, are explored. Volatile water treatment, its advantages, and its limitations are considered in this context. Results of an analysis based on a computer model of steam generator operation in such a steam supply system, of total boiler tube scale formation, limits, and control through water chemistry are presented. Material compatibility and chemical cleaning agents are discussed.

POWER REACTORS, NON-BREEDING, OTHERWISE MODERATED OR UNMODERATED

REFER ALSO TO CITATION(S) 41514, 41518, 41522

41366 (IAEA-CN—36/63) SGHWR fuel performance, safety and reliability. Pickman, D.O.; Inglis, G.H. (International Atomic Energy Agency, Vienna (Austria)). 1977. 7p. (CONF-770505—181). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.4.-.T.2./02 4 tables, 1 fig.

The design principles involved in fuel pins and elements need to take account of the sometimes conflicting requirements of performance, safety and reliability. The principal factors involved in this optimisation are discussed and it is shown from fuel irradiation experience in the Winfrith S.G.H.W.R. that the necessary bias toward safety has not resulted in a reliability level lower than that shown by other successful water reactor designs. Reliability has important economic implications and has to be paid for. By a detailed evaluation of S.G.H.W.R. fuel defects it is shown that very few defects can be shown to be related to design, rating or burn-up. This demonstrates that economic aspects have not over-ridden necessary criteria that must be met to achieve the desirable reliability level. It is possible that large-scale experience with S.G.H.W.R. fuel may eventually demonstrate that the balance is too much in favour of reliability and consideration may be given to whether design changes favouring economy could be achieved without compromising safety. The safety criteria applied to S.G.H.W.R. fuel are designed to avoid any possibility of a temperature runaway in any credible accident situation. The philosophy and supporting experimental work programme are outlined and the fuel design features which particularly contribute to maximising safety margins are outlined. Reference is made to new 60 pin fuel element to be used in the commercial S.G.H.W.R.'s and how it compares in design and performance aspects with the 36 pin element that has been used to date in the Winfrith S.G.H.W.R.

41367 (IAEA-CN—36/179) CANDU: Canadian experience and expectations with the heavy-water reactor. Foster, J.S.; Russell, S.H. (International Atomic Energy Agency, Vienna (Austria)). 1977. 8p. (CONF-770505—177). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

1.C.-.P.1./01 3 tables, 2 figs. Also available in French.

With the commissioning of the first two 750 MWe units of the Bruce generating station of Ontario Hydro there will be 9 nuclear-electric units with a total capcity of 4000 MWe operating in Canada. They represent nearly 7 per cent of the total installed electric generating capacity in the country and will supply about 9 per cent of the electrical energy consumed. Five similar units have been sold to other countries. All of these units employ CANDU natural-uranium-fuelled heavy-water-moderated pressure-tube reactors. Because of the high moderating efficiency of heavy water, reactors of this type are not only efficient units for operation on todays once-through fuel cycles but promise, with little or no alteration, to make very effective use of heavy-element resources through fuel cycles entailing the recycling of fissile material. The paper describes the evolution of the CANDU nuclear-power plants with particular reference to the objectives of safety, reliability and economy; the development of industrial capacity for the supply of fuel, components and heavy water; and the prospective development of advanced fuel cycles and the projected results. It provides data on radiation, releases, and exposures, internal and external to the power plants; plant availability, capacity factors and other performance data; economic data for operating plants in Canada; fuel and component manufacturing data; heavy water production data with reference to safety, reliability, and economics; projections of the performance of CANDU reactors operating on a thorium - U-233 cycle and the development required to establish this cycle; and intent with respect to spent-fuel management and radioactive-waste storage. The development of the CANDU reactor, of the associated supply industry, and of the thorium - U-233 advanced fuel cycle is seen as an integrated, evolutionary program, permitting increasingly efficient use of the world's heavy-element resources with thermal reactor technology.

41368 (IAEA-CN—36/184) CANDU fuel: fifteen years of power reactor experience. Fanjoy, G.R.; Bain, A.S. (International Atomic Energy Agency, Vienna (Austria)). 1977. 8p. (CONF-770505—176). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.4.-.T.2./01 1 table, 1 fig. Also available in French.

CANDU (Canada Deuterium Uranium) fuel has operated in power reactors since 1962. Analyses of performance statistics, supplemented by examinations of fuel from power reactors and experimental loops have yielded: (a) a thorough understanding of the fundamental behaviour of CANDU fuel; (b) data showing that the predicted high utilization of uranium has been achieved: actual fuelling costs in 1976 at the Pickering Generating Station are 1.2 m$/kWh (1976 Canadian dollars) with the simple once-through natural-UO_2 fuel cycle; (c) criteria for operation, which have led to the current very low defect rate of 0.03% of all assemblies and to "CANLUB" fuel, which has a graphite interlayer between the fuel and sheath to reduce defects on power increases; and (d) proof that the short length (500 mm), collapsible cladding features of the CANDU bundle are successful and that the fuel can operate at high-power output (current peak outer-element linear power is 58 +- 15% kW/m). Involvement by the utility in all stages of fuel development has resulted in efficient application of this fundamental knowledge to ensure proper fuel specifications, procurement, scheduling into the reactor and feedback to developers, designers and manufacturers. As of mid-1976 over 3×10^6 individual elements have been built in a well-estabilished commercially competitive fuel fabrication industry and over 2×10^6 elements have been irradiated. Only six defects have been attributed to faulty materials or fabrication, and the use of high-density UO_2 with low-moisture content precluded defects from hydrogen contamination and densification. Development work on UO_2 and other fuel cycles (plutonium and thorium) is continuing, and, because CANDU reactors use on-power fuelling, bundles can be inserted into power reactors for testing. Thus new fuel designs can be quickly adopted to ensure that the CANDU system continues to provide low-cost energy with high reliability.

41369 (IAEA-CN—36/385) India's nuclear power programme and constraints encountered in its implementation. Sethna, H.N.; Srinivasan, M.R. (International Atomic Energy Agency, Vienna (Austria)). 1977. 9p. (CONF-770505—182). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

7.0.-.P.1./01 4 tables.

Nuclear power development in India is based on the natural uranium fuelled pressurised heavy water reactors. However, in order to acquire early experience in operation and maintenance of nuclear power stations, India's first atomic power station comprised of two units of boiling water reactors. Subsequent nuclear power stations currently in operation or under construction employ natural uranium heavy water reactors and each of the stations is a two reactor installation. While the first two nuclear power stations employ reactors with an output of 235 MW. 500 MW heavy water reactors are visualised for the period beyond 1985. The first nuclear power station was essentially fully imported; the second nuclear power station which employs heavy water reactors already has a significant contribution of equipment manufactured in India. For the third nuclear power station and the subsequent one, practically all equipment is being manufactured indigenously. The nuclear power station at Narora is in a seismic region and hence the design is substantially more advanced than the ones at the earlier sites and also employs concepts which will be used in the 500 MW reactors. Efforts are being made in the country to integrate power generation systems into larger regional grids and eventually into a national grid; however, the distributed nature of power generation at present and other infrastructural limitations still favour small and medium size plants only. The paper brings out the efforts put in over the last ten years in establishing capability for design and manufacture of all equipment and systems required for nuclear power plants. A major constraint in expanding the nuclear power capacity is naturally related to the competing demands on available national resources. The paper also discusses other constraints than purely technological and financial and describes how efforts are being made to overcome these contraints.

41370 (IAEA-CN—36/394) **Innovations in PHWR design, integration of nuclear power stations into power systems and role of small size nuclear power plants in a developing country.** Mehta, S.K.; Kakodkar, A.; Balakrishnan, M.R.; Ray, R.N.; Murthy, L.G.K.; Chamany, B.F.; Kati, S.L. (International Atomic Energy Agency, Vienna (Austria)). 1977. 9p. (CONF-770505—179). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

7.2.-.T.1./04 1 table, 3 figs.

PHWR concept of thermal reactors has been considered with a view to exploiting the limited resources of natural uranium and keeping in mind the projected nuclear power programme covering fast breeder reactors. Experience in engineering of current PHWR units in India, gradual build up of necessary infrastructure and operational experience with one unit, have helped in building up design and technological capability in the country. The R and D facilities have been so planned that additional data required for the design of bigger reactor units (i.e.500/600 MWe) could be generated with minimal augmentation. Satisfactory operation of a nuclear power station demands certain prerequisites from the connected power system. The grid should have load patterns suitable for base load operation of these stations, should be stiff so far as voltage and frequency fluctuations are concerned and should have high reliability. A typical power grid in this country is characterised by heavy loads during peak hours and very light loads during night. Regional grids are of small size and the few interconnections existing between the regional grids consist of weak tie lines. Amongst all types of the power stations, it is the nuclear system which undergoes maximum strain and economic penalty while operating when connected to such a power system. Consistent with the above, phase installation of small-size power reactor units of about 200 MWe capacity may facilitate setting up of larger unit sizes at a later date. The effect of any possible reduction in the capital cost of a larger unit power station will enable the power station to partially meet the demand of the more productive types of loads. This paper deals with some of the major design changes that are being incorporated in the PHWR type power reactors currently being set up and the research and development back-up required for the purpose.

41371 (IAEA-CN—36/547) **Experience from construction and operation of Karachi nuclear power plant.** Zaidi, S.M.N. (International Atomic Energy Agency, Vienna (Austria)). 1977. vp. (CONF-770505—184). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

7.3.-.T.1./04 This entry prepared from abstract.

Pakistan's first nuclear power plant (KANUPP) is owned and operated by the Pakistan Atomic Energy Commission (PAEC). It uses a heavy water moderated and cooled natural uranium fuelled reactor. Total installed capacity is 137 MW(e). It was designed, constructed and commissioned by Canadian General Electric Co. Ltd. (CGE) as Prime Contractor. Construction started in mid-1966 and was completed in mid 1970; commissioning started in early 1970 and was completed at end of 1972. Intensive on-the-job training for 20 engineers and 15 operators was provided by CGE in Canada. Ten engineers also worked in CGE's design offices. With this key group of engineers and technicians PAEC had no difficulty in taking over the plant from CGE after completion. Construction of the plant in a developing country presented special problems to CGE. The relatively small local construction firms had limited experience and equipment. Construction plant, equipment and tools were scarce. Fabrication and workshop facilities of limited scope were available but their quotations were relatively high. A scarcity of engineering, technical and skilled manpower for the construction of the project left as the only alternative on-site training for carefully recruited technicians. The results were most gratifying and compared favourably with CGE's Canadian experience. Welding, pipe fitting, tubing work and electrical connections were excellent. The local staff's productivity and dedication were very good. In the commissioning period, PAEC and CGE engineers and technicians worked as one team, testing and debugging the equipment and systems and demonstrating the contractual performance warranties. This period extended to approximately three years due to many technical problems resulting from equipment failures, environmental problems, system problems, plant loading limitations in view of the relatively small size of the grid system and special requirement of fuel conditioning to avoid premature fuel failures.

41372 (INIS-mf—3389, pp 103-113) **Preparing periodic inspections of A-1 reactor pressure vessel.** Elger, R. (Skoda, Plzen (Czechoslovakia). Zavod Vystavba Jadernych Elektraren). 1974. (In Czech).

In In-service inspection and diagnostics of nuclear power installations. Part 1.

Periodic inspection is an indispensable precondition for the reliable long-term operation of pressure vessels. The main principles were set for periodic inspections of the Bohunice A-1 reactor pressure vessel. Access to the pressure vessel, the measurement of dose rates in the neighbourhood of the vessel, the effects of transients on vessel stress were evaluated. The method of acoustic emission was studied for the indication and localization of spreading defects in the pressure vessel material.

41373 (INIS-mf—3389, pp 56-65) **In-service inspection and diagnostics of A-1 power plant blowers.** Svoboda, V.; Greif, K. (CKD Praha (Czechoslovakia)). 1974. (In Czech).

In In-service inspection and diagnostics of nuclear power installations. Part 1.

Measurement methods and instrumentation used in the complex testing of blowers for the A-1 nuclear power plant are described. The results of the measurement made it possible to evaluate the operating areas of minimal and maximal pulsations, the frequency spectrum, the relation between pressure pulsations and the dynamic stress of the wheel.

41374 (VR—688/76) **Thermal strain effect of welding on the properties and stress state of welded joints in the pressure vessel of the A 1 reactor.** Becka, J.; Kupka, I. (Riecansky (V.E.) Technical Translations, Balsham, Cambridge (UK)). 1976. 18p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Translated from Zvaranie v. 25(3), 1976, p. 72-77. Available from V.E. Riecansky Technical Translations, Cambridge, price Pound6.00.

Results are presented of welding and detailed evaluation of test plates and rings of actual sizes, and the results are related directly to the determination of the thermal conditions of the welding of the A1 steel reactor vessel. Electro slag welding and automatic CO_2 welding were used. Details are given of the materials used and the conditions of the tests. Test results and analysis are given under the following heads: thermal cycles, microstructure, notch toughness; strain effect, stress state, specific accumulated energy; temperature of brittle crack initiation, the critical size of the initial flaw; conclusions.

41375 **Pickering generating station.** Morison, W.G. (Ont Hydro, Pickering generating stn). *Chart. Mech. Eng.;* **22**: No. 7, 62-66(Jul 1975).

Canada has completed four of the eight units in the Pickering Generating Station on the North shore of Lake Ontario. This group, known as Pickering A, was commissioned in 1973 and became the largest fully operational nuclear station in the world, attaining a net capacity of 83 per cent of the theoretical maximum. The interesting design and construction of the Canadian station are described. Up to the end of 1974, the average net station availability, covering approximately nine unit years of operation, had been approximately 80 per cent. During the winter peak load it was above 95 per cent. Pickering A uses natural uranium oxide as fuel and heavy water as a moderator and coolant in a reactor with horizontal pressure tubes that can be fuelled on-power. The station comprises four units, each with a designed net electrical output of 508 MW. Up to the end of 1974, Pickering A produced 35.4 GWh of electricity near a major load center. It is now providing approximately 15 per cent of the electrical energy of Ontario substantially cheaper than the most efficient fossil-fired stations. The cooling water is drawn from and returned to Lake Ontario with a maximum increase in temperature

of 11$degree$C and no significant adverse environmental effect. 2 refs.

41376 Nuclear power: its value is distorted for political ends. *West. Miner;* **48**: No. 8, 21-22, 24-25(Aug 1975).

A logical and much needed source of energy is being hindered in its development, mainly on the grounds of safety hazards. Nevertheless there are plans for major developments in Canada and worldwide. The current program for CANDU (Canadian Deuterium Uranium) power reactors is discussed and presented in tabular form. One advantage of the CANDU reactor is that it uses natural uranium as fuel.

41377 If Canada CANDU--can we. *Energy (Stamford, Conn.);* **1**: No. 2, 15-15(1976).

The U.S.'s Energy Research and Development Administration is exploring with Atomic Energy of Canada Ltd (AECL) the possibility of either licensing Canadian know-how, or independently developing a parallel system to give the U.S. heavy water reactors. The Canadian Candu heavy water reactor has a number of advantages, such as online refueling, possibly quicker construction and lower-cost power, but these alone would not weigh much against the U.S.'s heavy commercial commitment to light water reactors (LWR's). On the surface, U.S. utilities would appear poor prospects for yet another new kind of nuclear reactor.

POWER REACTORS, BREEDING

REFER ALSO TO CITATION(S) 41312, 41320, 41321, 41437, 41467, 41509, 41510, 41512, 41513, 41519, 41521, 41527, 41529, 41532, 41533, 41546, 41548, 41549, 41550, 41551, 41552, 41554, 41556, 41604, 41631, 41794

41378 (AI-ERDA—13191) **High-temperature piping design technology quarterly technical progress report, October—December 1976.** (Atomics International Div., Canoga Park, Calif. (USA)). 9 Feb 1977. Contract EY-76-C-03-0824. 21p. Dep. NTIS, PC A02/MF A01.

Information on LMFBR type reactor high temperature piping is presented concerning failures of high temperature sodium piping systems and creep-fatigue testing of 2¼ Cr—Mo steel.

41379 (CONF-770401—6) **Analysis of a fuel-pin neutron-streaming experiment to test methods for calculating neutron damage to the GCFR grid plate.** Slater, C.O.; Emmett, M.B. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 9p. Dep. NTIS, PC A02/MF A01.

From 5. international conference on reactor shielding; Knoxville, Tennessee, United States of America (USA) (18 Apr 1977).

A summary of the analysis of a neutron streaming experiment performed at the ORNL Tower Shielding Facility in 1975 is presented. The experiment was performed in support of the GCFR shield design effort to determine if design methods were adequate to calculate the radiation sources which would have to be shielded against. The experiment was analyzed with two-dimensional (2-D) discrete ordinates and Monte Carlo methods. The 2-D results for homogeneous and heterogeneous models of the pin array bracketed the measured results, but large discrepancies between the models occurred for detector angles less than 2.5^0 from the pin array axis. The Monte Carlo results showed much improvement over the 2-D results, yet these still deviated greatly from the measured results.

41380 (CONF-770401—8) **Measurements and calculations of neutron fluxes through a simulation of the CRBR upper axial shielding.** Maerker, R.E.; Muckenthaler, F.J. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 8p. Dep. NTIS, PC A02/MF A01.

From 5. international conference on reactor shielding; Knoxville, Tennessee, United States of America (USA) (18 Apr 1977).

Comparisons of two-dimensional calculations with measurements from the recently completed upper axial shield experiment performed at the Tower Shielding Facility have been made, in which neutron attenuations over a range of 10^{12} were measured through various combinations of stainless steel followed by sodium followed by carbon steel. The calculations using a standard design cross section set with a standard transport code reveal disagreements with measurements behind the thickest shields by at most a factor of about three, but in most of the cases the agreement lies within 30 percent. Attempts at one-dimensional scaling of this experiment have also been successful, and fine-group calculations indicate that the basic ENDF/B-IV cross section data must be updated for sodium.

41381 (CRBRP-ARD—0106(Vol.3)) **Clinch River Breeder Reactor Plant. Appendix B. FORTRAN IV index listing of the VARR II program.** Cook, J.L.; Nakayama, P. I. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Nov 1976. Contract E(49-18)-12-3;E(11-1)-2395. 143p. AT.

41382 (CS-INIS—29) **Fuel rods vibration in fast breeder reactors.** Appelt, K.D.; Kadlec, J.; Krueger, W. (Atomova Elektraren Bohunice, Jaslovske Bohunice (Czechoslovakia)). [nd]. 15p. (In Czech). (P—674). Dep. NTIS (US Sales Only), PC A02/MF A01.

Translation of paper presented at conference on "Structural Mechanics in Reactor Technology", Berlin, 1972. Available from Atomova Elektraren, Jaslovske Bohunice, Czechoslovakia.

The analysis was made of sources of fuel rod vibration in fast breeder reactors. These are long rods with a small outer diameter whose spacing is determined by spacing grids. A simplified mathematical model is constructed and a solution is presented for several types of boundary conditions. Theoretical speculations are completed with results of experimental research at excited vibrations of the fuel rod and vibrations due to the hydrodynamical effects of turbulent flow in an experimental water loop. The results of the experiments are described.

41383 (GA-A—14236) **Gas-cooled fast breeder reactor shielding benchmark calculation.** Rouse, C.A.; Mathews, D.R.; Koch, P.K. (General Atomic Co., San Diego, Calif. (USA)). Jan 1977. Contract EY-76-C-03-0167-023. 40p. Dep. NTIS, PC A03/MF A01.

This report summarizes the results of a shielding benchmark calculation performed by General Atomic (GA) and Oak Ridge National Laboratory (ORNL). The problem analyzed was a neutron-coupled gamma ray transport calculation of the core blanket shield of the 300-MW(e) gas-cooled fast breeder reactor (GCFR). Comparison of the initial GA and ORNL results indicated good agreement for fast fluxes (E greater than 0.9 MeV and E greater than 0.086 MeV) but poor agreement for epithermal and thermal neutron fluxes. Examination of the results revealed that a deficiency in the GA fine-group cross section preparation code was responsible for the differences in the GA and ORNL iron cross sections. Modification of the GA cross sections to include self-shielding was accomplished, and the updated GA benchmark calculation performed with the self-shielded iron cross sections was in excellent agreement with the ORNL results for fast neutron fluxes with E greater than 0.9 MeV and E greater than 0.086 MeV and in good agreement for epithermal and thermal fluxes. The agreement of the gamma heating rates also improved significantly. Thus, it was concluded that the good agreement of the GA and ORNL neutron-coupled gamma ray transport calculation indicates that (1) the methods and cross sections used by both laboratories were compatible and consistent and (2) the use of 24 neutron energy groups and 15 gamma energy groups by GA was adequate compared with the use of 51 neutron energy groups and 25 gamma energy groups by ORNL.

41384 (GA-A—14240) **Gas-cooled fast breeder reactor. Quarterly progress report, November 1, 1976—January 31, 1977.** (General Atomic Co., San Diego, Calif. (USA)). Feb 1977. Contract EY-76-C-03-0167. vp. Dep. NTIS, PC A12/MF A01.

Progress is described in the areas of development of GCFR fuel, blanket, and control assemblies; development of the pressure equalization system for GCFR fuel; out-of-pile loop facility test programs; fuels and materials development; fuel, blanket, and control rod analyses and development; nuclear analysis and reactor physics for GCFR core design; shielding requirements for the GCFR; reactor engineering to assess the thermal, hydraulic, and structural performance of the core and the core support structure; plant systems control; systems engineering; development of reactor components, including reactor vessel, control and locking mechanisms, fuel handling equipment, core support structure, shielding assemblies, main helium circulator, steam generator, and auxiliary circulator; development of a helium circulator test facility; reactor safety, environment, and risk analyses, including planning and support of an in-pile and out-of-pile safety test program; nuclear island engineering design; and development of a reliability data bank.

41385 (GEAP—10028-60) **Core engineering sixtieth quarterly report, August—October 1976.** (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Nov 1976. Contract EY-76-C-03-0893. 42p. AT.

Progress during August, September, and October 1976 is described on Fuel Assembly Engineering and Core Component Design and Analysis.

41386 (GEAP—13771-21) **Critical experiments and analysis twenty-first quarterly report, October—December 1976.** (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Jan 1977. Contract EY-76-C-03-0893-005. 107p. AT.

Current activities and technical progress for the period October through December 1976 are reported for two subtasks. Subtask A covers the technical direction for critical experiments and analysis as applicable to LMFBR commercial plants and the Clinch River Breeder Reactor Plant Benchmark Critical Experiments in ZPPR Assembly 4 and the CRBRP EMC. Subtask B is directed towards the analysis of advanced fuels critical experiments that can provide a consistent data base for testing the computational tools, nuclear analysis techniques and basic nuclear data which are used in the LMFBR design effort, and for evaluating the nuclear performance and safety characteristics of advanced fuel materials.

41387 (GEAP—14078-5) **Advanced LMFBR core design. Fifth quarterly report, July—September 1976.** (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Oct 1976. Contract EY-76-C-03-0893. 36p. AT.

Progress is reported in the areas of advanced mechanical core design and advanced oxide fuel systems design and tradeoff studies.

41388 (HEDL-SA—1122) **Caustic stress corrosion cracking.** Funk, C.W.; Barton, G.B. (Westinghouse Hanford Co., Richland, Wash. (USA)). 1977. Contract E(45-1)-2170. 27p. (CONF-770303—11). Dep. NTIS, PC A03/MF A01.

From Corrosion/77 NACE meeting; San Francisco, California, United States of America (USA) (14 Mar 1977).

Liquid Metal Fast Breeder Reactors (LMFBRs) use sodium as a coolant for transfer of heat from the core to the steam generators. Maintenance and examination of the system require removal of sodium from components of the system. One process for removal reacts the sodium with water vapor and removes the residual sodium hydroxide from the components by rinsing with liquid water. This process exposes components such as pumps, heat exchangers, valves, and fuel-handling machines to contact with aqueous NaOH solutions in various concentrations over a range of temperatures and times. Since stress can be present in these components, as generated by fabrication, structural loads, deformation in service, and possible wedging action by corrosion products, conditions are potentially available for the mechanism of caustic stress corrosion cracking (CSCC). Since LMFBR components are fabricated from Types 304 and 316 stainless steels which have been found to be susceptible to CSCC, it was therefore considered necessary to establish the threshold of CSCC so that the components could be processed under conditions avoiding CSCC. The materials used in the testing program included heats of Types 304 and 316 stainless steel, Inconel 600 and 718, hardfacing deposits of Stellite 6 and 156, and three special wear-resistant, carbide-type materials. The analysis of these materials is tabulated.

41389 (HEDL-TME—76-66) **Temperature and voltage tests on MgO insulated coaxial cables.** Cannon, C.P. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Feb 1977. Contract EY-76-C-14-2170. 32p. AT.

MgO insulated nuclear instrumentation cables, designed for use in in-vessel LMFBR environments, were procured using special HEDL/vendor developed specifications and tested. The ultimate goal is operation at 650°C, 800 Volts direct current (Vdc); a key intermediate goal for specific applications is operation at 450°C, 800 Vdc. The cables satisfied all test requirements, including absence of Breakdown Pulse Noise (BPN), during long-term tests (600 hours) at 450°C, 1000 Vdc continuous. BPN did not occur on half of these same cables at 650°C, 1000 Vdc. Also, it was determined that cable performance was not affected by air, nitrogen and nitrogen-1 percent helium fill gas variations but was affected by fill gas pressure and insulation contamination.

41390 (IAEA-CN—36/54) **Status and programme for the fast breeder reactor in the UK.** Franklin, N.L; Hill, J. (International Atomic Energy Agency, Vienna (Austria)). 1977. vp. (CONF-770505—189). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

1.D.-.P.1./04 This entry prepared from abstract.

The paper briefly reviews the long-standing objectives and strategy for the introduction of the Fast Breeder Reactor in the U.K. and goes on to comment upon the early operation of the prototype PFR and on the status of the design of the first commercial demonstration plant DFR 1. The arrangements for the supporting technology and component development are discussed together with the contributions that can follow from collaboration. The out-of-pile fuel cycle, so critical to the success of the fast reactor power programme, has its principal objectives and timescales identified and these form the bases of the several U.K. papers that follow in this Conference.

41391 (IAEA-CN—36/64) **Fast reactor fuel design and development.** Bishop, J.F.W.; Chamberlain, A.; Holmes, J.A.G. (International Atomic Energy Agency, Vienna (Austria)). 1977. 10p. (CONF-770505—133). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.5.-.T.2./08 6 figs.

Fuel design parameters for oxide and carbide fast reactor fuels are reviewed in the context of minimising the total uranium demands for a combined thermal and fast reactor system. The major physical phenomena conditioning fast reactor fuel design, with a target of high burn-up, good breeding and reliable operation, are characterised. These include neutron induced void swelling, irradiation creep, pin failure modes, sub-assembly structural behaviour, behaviour of defect fuel, behaviour of alternative fuel forms. The salient considerations in the commercial scale fabrication and reprocessing of the fuels are reviewed, leading to the delineation of possible routes for the manufacture and reprocessing of Commercial Reactor fuel. From the desiderata and restraints arising from Surveys, Performance and Manufacture, the problems posed to the Designer are considered, and a narrow range of design alternatives is proposed. The paper concludes with a consideration of the development areas and the conceptual problems for fast reactors associated with those areas.

41392 (IAEA-CN—36/164) **Programme and current status of fast breeder reactor development in Japan.** Suita, T.; Oyama, A. (International Atomic Energy Agency, Vienna (Austria)). 1977. 14p. (CONF-770505—202). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

1.D.-.P.1./05 2 tables; 4 figs.

In 1967 the Japan Atomic Energy Commission revised her long term programme after a two year study for giving principles to her nuclear energy development programme, which indicated the dominant role of nuclear energy mid 1980's in the electric power generation and stressed the necessity of developing fast breeder reactors. It also recommended to organize a nucleus to undertake this nation-wide project, bringing together the total capability available throughout the country. Accordingly, the Power Reactor and Nuclear Fuel Development Corporation (PNC) was established in 1967 to develop two sodium-cooled fast reactors, an experimental fast reactor of about 100 MW thermal and a prototype fast breeder reactor of about 300 MW electrical, both using mixed oxide fuels. Construction of the experimental fast reactor started in 1970 and was essentially completed at the end of in 1974. The precommissioning test was followed in parallel with re-evaluating quality assurance of all systems. Physics test will be initiated around the end of 1976. The conceptual design of the prototype fast breeder reactor is now toward its final stage. Surveys on its proposed site have just started. Construction will start in 1978. Beside R and D works conducted by many organizations in Japan as well as under the international cooperation, several key test facilities were installed by PNC itself to conduct in-sodium test of full-size prototype components including 50 MW steam generators and post-irradiation-examination of fuels and materials. Recently an interim report was issued to an ad-hoc committee organized by JAEC to evaluate future prospect of the fuel cycle and power reactors. This recommended start of construction of the prototype reactor as scheduled and the large demonstration reactor to be followed to the prototype. Thus the fast breeder reactor is indicated as the most indispensable in 1990's.

41393 (IAEA-CN—36/266) **Rapsodie: A closed fuel cycle.** Levallet, E.H.; Costa, L.; Mougniot, J.C.; Boudry, J.C.; Miquel; Robin, J. (International Atomic Energy Agency, Vienna (Austria)). 1977. 13p. (In French). (CONF-770505—194). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.5.-.T.2./06 1 fig.

The Fortissimo Version of the core of the RAPSODIE fast reactor produces 40 MWTh. Since its start up in May 1970 in the CEN-CADARACHE its availability has stayed around 85%. Some of the mixed oxide fuel pins UO_2 - 30% PuO_2 have already reached 150.000 MWd/t. The reprocessing is done in the pilot plant located in the La Hague Center and the plutonium obtained has already been re-used in the reactor. The Rapsodie-Fortissimo cycle is therefore now a closed cycle. This cycle is quite representative of fast reactor cycle characteristics and thus provides a remarkable research and development tool for the study of fabrication, in-reactor performances, transport, storage and reprocessing. These studies concern in particular the evolution of fission products and heavy isotopes content in fuel which controls both reprocessing schemes and intensity of emitted radiations. A program for the analysis of irradiated fuel has been developed either using samples collected all along the cycle, or following the actual reprocessing subassemblies. A set of basic data and calculation models has been established with two objectives: to give a better interpretation of the experimental program on one hand, and to extrapolate these results to the fuel cycle of fast reactors in general on the other hand. The first results have been quite encouraging up to now.

41394 (IAEA-CN—36/268) **Characteristics and behaviour of the PHENIX fuel element.** Delpeyroux, P.; Balloffet, Y.; Blanchard, P.; Courcon, P.; Jallade, M.; Millet, P.; Rousseau, J.; Carteret, Y.; Coulon, P.; Dupouy, J.M. (International Atomic Energy Agency, Vienna (Austria)). 1977. 6p. (In French). (CONF-770505—188). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.5.-.T.2./08 7 figs. Also available in English.

The Phenix reactor has been in regular industrial operation for two years and has functioned very satisfactorily thanks in particular to the very good behaviour of the fuel element. A brief description is given of the fuel element and the operating conditions which were set for the fuel at the time of start-up (50000 MWd/t).

The surveillance scheme is then described with the examinations in the hot laboratory on the basis of which it was possible to achieve the nominal specific burn-up and then to clear the Phenix fuel for a specific burn-up of 60000 MWd/t or 7 at.%. The behaviour of the mixed oxide $(U, Pu)O_2$ is quite normal and conforms to predictions as regards the heat conditions, swelling and fission gas release. The corrosion reaction between the oxide and the clad is progressing slowly and affects only small thicknesses of cladding. The mechanical integrity of the clad under thermal stresses and the stresses produced by swelling and fission gas pressure do not pose any special problem. The present limitation of the irradiation level is essentially based on the permissible deformations due to swelling and irradiation creep in the fuel pin cladding and in the hexagonal tube. This corresponds to damage to the steel of the order of 80 dpa. The mechanical behaviour of the bundle of pins, its interaction with the hexagonal tube and the thermohydraulic consequences of the deformations are all satisfactory to date. The absence of fuel failures is also worth noting; the only burst can detected to date did not affect either the operation of the fuel assembly or the performance of the reactor.

41395 (IAEA-CN—36/302) **Status and prospects of thermal breeders.** Went, J.J. (International Atomic Energy Agency, Vienna (Austria)). 1977. 12p. (CONF-770505—204). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

8.0.-.T.1./01 1 table, 4 figs.

The utilization of the thorium-uranium 233 cycle instead of the uranium-plutonium 239 cycle for breeders or near breeders has played - up till now - only a minor role for a future large scale nuclear energy production. However such promising development results have been obtained with thorium fueled reactor systems that the situation needs to be reconsidered again very seriously. In the United States, the Oak Ridge National Laboratory has developed and operated a small scale molten salt reactor system. In the Netherlands, the KEMA laboratories have operated successfully a small aqueous homogeneous suspension system with a power density in the reactor vessel, quite sufficient for a power reactor. In this respect also the possibilites of CANDU reactors and HTGR reactors fueled with the thorium cycle should be reconsidered. Finally the review of thermal breeding would be incomplete without evaluating the "Seed and Blanket" reactor at Shippingport. Although there is a common sense that the present day Light Water Reactors (LWR's) are technically and economically acceptable, it has been realized that the uranium resources are completely insufficient for a large scale nuclear energy production. The reason is that only 1-1 1/2% of the natural uranium mined can be converted into useful energy in LWR's. In breeder reactors however fissioning of 10-50% of the nuclear material is possible. This means that 7-30 times more can be payed for the natural uranium. The practically unlimited amounts of uranium e.g. in seawater are then available. This means too that no uranium monopolies in the world will exist and that future energy requirements are guaranteed.

41396 (IAEA-CN—36/326) **Physical characteristics of fast power reactor fuel and their effect on the fuel cycle.** Bakumenko, O.D.; Ikhlov, E.M.; Kulakovskii, M.Ya.; Romashkin, B.G.; Troyanov, M.F.; Tsikunov, A.G. (International Atomic Energy Agency, Vienna (Austria)). 1977. 14p. (In Russian). (CONF-770505—186). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.7.-.T.1./10.

The influence of higher plutonium isotopes on the inherent fuel activity and radiation situation when fabricating fuel elements and handling plutonium fuel is analyzed. Contribution from AM-241 and Pu 236 decay products build-up to the total activity is evaluated as a function of time elapsed from fuel reprocessing, till reloading a reactor. Main physical characteristics of spent fuel from fast power reactors, i.e. fuel isotopic composition, residual heat release and activity values, are presented. Data are given on transuranium elements build-up values in the discharged fuel as a function of the fuel isotopic composition, on the transuranium elements build-up effect upon the activity and residual heat release in the discharged fuel. On the basis of the fuel, inherent activity requirements for the degree of fast reactor fuel fission-products decontamination by chemical reprocessing are determined. The dynamics of the fuel residual heat release and activity variations are considered under conditions of reduced cooling times. The effect of the fuel delay time before its charging into the reactor upon the residual heat release value and neutron activity of the discharged fuel is evaluated. Engineering problems connected with the above mentioned fuel properties and arising from the spent fuel cooling time reduction in the external fuel-cycle systems are discussed on the basis of the material presented. In conclusion, the relations between different fuel-cycle steps and the influence of the external fuel-cycle time upon fast reactor power system development rates are considered.

41397 (IAEA-CN—36/332) **Basic performance problems and prospects for 1200-1500 Mw gas-cooled fast reactors with the dissociating coolant.** Krasin, A.K.; Nesterenko, V.B.; Tverkovkin, B.E.; Zelenskii, V.F.; Naumov, V.A.; Gol'tsev, V.P.; Kovalev, S.D.; Kolykhan, L.I. (International Atomic Energy Agency, Vienna (Austria)). 1977. 16p. (In Russian). (CONF-770505—193). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

8.0.-.T.1./05 3 figs. Also available in English.

Investigations of atomic power stations with fast reactors showed that realization of high specific concentrations of the nuclear fuel and high values of thermal stress between 600 and 1000 kv/l is required to obtain short doubling times. Theoretical, experimental and engineering developments show that the dissociating system is a promising coolant for a gas-cooled fast reactor. The chemically reacting N_2O_4 compared to Na has the advantage of an intensive heat removal and high values of thermal stresses and compared to gas coolants, in particular He, has a negligible effect on the neutron spectrum softening. The main characteristics of gas-cooled reactors with N_2O_4 and the results of thermal, hydraulic and physical calculations are presented. It is possible to achieve thermal stresses between 800 and 1000 kv/l and obtain the doubling times of 5-6 years at the maximum temperature of the fuel cladding wall between 650 and 680°C, at the outlet gas temperature in the range of 450-480°C, at the pressure -150-170 bar and gas reheating in the reactor by 230-270°C. Fuel compositions on the UO_2-base in the matrix performance are proposed. The main theoretical and experimental investigations substantiating design developments are given.

41398 (IAEA-CN—36/356) **USSR fast reactor development program and its current state.** Kazachkovskii, O.D.; Meshkov, A.G.; Mitenkov, F.M.; Vasilenko, K.T.; Gryazev, V.M.; Kiselev, G.V.; Kochetkov, L.A.; Lytkin, V.B.; Pakhomov, V.V.; Savin, N.I. (International Atomic Energy Agency, Vienna (Austria)). 1977. 17p. (In Russian). (CONF-770505—190). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

1.D.-.P.1./02 5 figs. Also available in English.

Fast reactors make it possible to use in the most efficient way 1) uranium resources; 2) plutonium produced by thermal reactors; 3) plutonium surplus which can arise in the power system due to fast reactors operation. These features of the fast breeder reactors offer the best way to realize the main advantage of nuclear power plants as compared to conventional ones: low fuel component of the power cost within the total power system. The USSR Fast Reactor Development Program having started with studies on nuclear physics and reactor physics about twenty-five years ago has now reached the industrial level when first power fast reactors design and construction became possible. The goal of this program is to create competitive and reliable enough commercial nuclear power plants with fast breeder reactors. In this connection the program includes further investigations on reactor physics, fuel and structural materials, on the development of a sufficiently short external fuel cycle, on the advancement and enlargement in size of reactor plant equipment, and on safety problems. The start-up of the BN-350 first industrial fast reactor in Shevchenko in November 1972 proved to be possible due to tremendous work carried out during previous years on the development and large scale tests of fuel elements, on sodium technology, sodium-system components development and testing. Now, after steam-generators repair, the BN-350 reactor is operated at 650 Mw thermal capacity (65% of its rated value), fuel burn-up is approaching the target value of 5% of heavy atoms. The BOR-60 fast test reactor started up in late 1969 in Dimitrovgrad successfully continues to work, its maximum actual fuel burn-up being 11.7-13.2% of heavy atoms. The reactor is used for tests of fuel elements, structural materials and different steam-generator types. The second large-scale fast reactor, the BN-600 of 600 Mw electric power is under construction now.

41399 (IAEA-CN—36/369) **Behaviour of mixed monocarbide and -nitride fuel under high power density.** Blank, H.; Lindner, R.; Matzke, H. (International Atomic Energy Agency, Vienna (Austria)). 1977. 11p. (CONF-770505—134). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.6.-.T.1./07.

At the European Institute for Transuranium Elements, the Karlsruhe Establishment of the Joint Research Centre of the European Communities, an essential part of the working force has been dedicated to the investigation of uranium-plutonium carbide, carbonitride, and nitride fuel behaviour under limit conditions in fast neutron reactors (high linear heat ratings). The research is conducted in perpetual correlation and feedback between laboratory investigations in materials science and specified irradiations or evaluations of other relevant ongoing irradiations. The phenomenon of fuel

swelling is regarded as one of the most important limiting factors for fuel pin lifetime (independent of other limiting factors for the life of the reactor core) and the mechanisms contributing to swelling have been analysed in detail by means of studies on fission gas precipitation, fuel restructuring, creep, radiation-enhanced diffusion and others. As far as the contribution by fission gas swelling is concerned, the notion of a "critical temperature" has been introduced, above which accelerated swelling takes place and which, in itself, is a function of burn-up. This concept is being tested and quantified in a special irradiation series. Also, the mechnical effects leading to cracking and relocation of the fuels are subject to specific experiments. Some speculative overall picture of the process is presented in the paper, although the work will occupy the attention of the laboratory for several years to come.

41400 (IAEA-CN—36/424) **MSR (Pu converters) and MSBRs in commercial nuclear power stations.** Reichle, L.F.C. (International Atomic Energy Agency, Vienna (Austria)). 1977. 5p. (CONF-770505—198). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

8.0.-.T.1./02 4 charts. Also available in French.

Molten Salt Reactors are likely to be the best way to achieve lowest-cost, safe, reliable and environmentally compatible commercial nuclear power in the early 1990's. This conclusion is based on work performed by the industrial members of the U.S. Molten Salt Group and by the Oak Ridge National Laboratory - both of whom are in general agreement on the status and prospects of Molten Salt Reactor technology. The MSBR Development Program is a 14-year program comprised of a 250 MWe MSTR (Molten Salt Test Reactor), a 1,000 MWe MSBR (Molten Salt Breeder Reactor) Demonstration Plant, and related development work. Plutonium from LWRs will fuel MSR (Pu Converters) which, in turn, will produce U-233 to fuel MSBRs. Because of the low inventory of fissile material in MSRs, a given amount of Pu will start-up many more MSRs than LMFBRs or GCFRs. MSRs can be expected to produce energy at a cost that will be competitive with LWRs before LMFBRs or GCFRs. They will use less uranium and require less enrichment. They will have a much lower development cost. They have the potential of producing high-temperature process heat. MSRs use a fluid fuel, and therefore eliminate the high cost of fuel fabrication. They have on-stream refueling and high thermal efficiency. They will have construction costs comparable to LWRs. MSRs have relative safety and environmental advantages, such as no possibility of a LOCA, low inventory of fissile material, continuous removal of fission products, and on-site storage of spent fuel wastes.

41401 (IAEA-CN—36/427) **Status and program of development of the fast breeder reactor system in the U.S.** Roberts, R.W. (International Atomic Energy Agency, Vienna (Austria)). 1977. 11p. (CONF-770505—201). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

1.D.-.P.1./03.

The U.S. Energy Research and Development Administration's highest priority breeder concept is the Liquid Metal Fast Breeder Reactor (LMFBR). Its objective is the development of a broad technological and engineering base with extensive utility and industrial involvement which will establish a timely capability for a competitive and commercial breeder industry. In addition to technological development, an integral part of the LMFBR program is the transfer of LMFBR technology to the nuclear industry and the parallel development of utility capability. An important indicator of the effectiveness of this program is the successful construction and operation of a number of LMFBR experimental and test reactors and associated non-nuclear test facilities such as those located at Santa Susana, California, the Argonne (III). National Laboratory and the Hanford Engineering Development Laboratory at Richland, Washington. A principal element of the U.S. fast breeder reactor program is the Fast Flux Test Facility (FFTF). The largest test reactor facility in the world, the FFTF will focus on the testing of fuels and material. The FFTF, being built at the Hanford Engineering Development Laboratory, is scheduled for completion in the late 1970's. The next step toward timely commercial breeder capability is to implement a program for a large-scale demonstration of this concept. A 380 megawatt electrical demonstration plant - designated the Clinch River Breeder Reactor Plant (CRBRP) - will be constructed and operated near Oak Ridge, Tennessee, under a cooperative arrangement of industrial contractors, utilities, and the Government. The completion date is 1983. The estimated cost of the CRBRP project is 1.95 billion dollars. This includes the cost of design, construction, related research and development, and five years of operation - the full timespan from the project's beginning in 1972 through completion.

41402 (IAEA-CN—36/478) **Need for high performance breeder reactors.** Vaughan, R.D.; Chermanne, J. (International Atomic Energy Agency, Vienna (Austria)). 1977. 7p. (In French). (CONF-770505—203). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

8.0.-.T.1./03 3 figs.

It can be easily demonstrated that an increasing portion of the growth in energy demand must be supplied by nuclear power, which might account for 20% of all the energy production by the end of the century. Such assumptions lead very quickly to the conclusion that the discovery, extraction, and processing of the uranium will not be able to follow the demand; the bottleneck will essentially be related to the rate at which the ore can be discovered and extracted, and not to the existing quantities nor their grade. Figures as high as 150.000 T/annum and more would be quickly reached, and it is necessary to wonder if enough capital can be attracted to meet these requirements. There is only one solution to this problem: improve the conversion ratio of the nuclear system and quickly implement breeding; this would lead to the reduction of the natural uranium consumption by a factor of about 50. However, this condition is not sufficient; the commercial breeder must have a breeding gain as high as possible because the Pu out-of-pile time and the Pu losses in the cycle could lead to an unacceptable doubling time for the system, if the breeding gain is too low. That is the reason why it is vital to develop high performance breeder reactors. The present paper indicates how the Gas-cooled Breeder Reactor [GBR] can meet the problems mentioned above, on the basis of recent and realistic studies. It briefly describes the present status of GCFR development, from the predecessors in the gas cooled reactor line, particularly the AGR. It shows how the GCFR fuel takes mostly profit from the LMFBR fuel irradiation experience. It compares the GCFR performance on a consistent basis with that of the LMFBR. The GCFR capital and fuel cycle costs are compared with those of thermal and fast reactors respectively. The conclusion is, based on a cost-benefit study, that the GCFR must be quickly developed in order to guarantee the achievement of the breeding and the energy supply in the future.

41403 (IAEA-CN—36/489) **Introducing experimental evidence in critical aspects of SNR fuel design.** Michel, A.; Stevens, L.; Toebbe, H.; Biermann, W. (International Atomic Energy Agency, Vienna (Austria)). 1977. 11p. (CONF-770505—196). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.5.-.T.2./09 4 figs. Also available in French.

The design of fuel elements and fuel pins for SNR-300 is based on a set of calculating methods. The confidence in these methods rests on careful calibration of the models used by comparison with experimental in-pile and out-of-pile evidence and by demonstration of the reliability of the components thus designed. The results, i.e. a typical fuel assembly design, is then tested and its behaviour compared with predictions. This is a classical procedure but the particular situation of SNR is that it being a first of its kind in the DEBENELUX countries, the designer could not acquire confidence by accumulation of very large amounts of irradiation results, thus gaining statistical significance. To compensate for this situation, the designers developed very sophisticated computer methods which could be tested by comparison with experiments planned, checked and measured in great details. The paper gives an overall view of the chain of programs used for pin and bundle mechanical and thermohydraulic design. It presents a certain number of experiments which had been aimed at the solution of a particular problem: maximum allowable cladding temperature under irradiation, temperature distribution in small geometries, grid geometry effect on pressure drop, fuel central temperature, effect of swelling and creep on bundle deformation, etc... These experiments enter into broad categories: either the phenomena can be isolated and an experiment performed to check exactly a particular model of calculation or basic assumption e.g. pressure drop coefficient of grid element in a single subchannel, or a global situation is represented and compared to parallel calculations. A brief analysis of each experiment essentially shows its impact on fuel design methods and the level of confidence in the results.

41404 (IAEA-CN—36/497) **Status and programme of development of the fast breeder reactor systems in the Federal Republic of Germany.** Daeunert, U.; Kessler, G. (International Atomic Energy Agency, Vienna (Austria)). 1977. vp. (CONF-770505—187). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

1.D.-.P.1./06 This entry prepared from abstract.

Owing to the dependence of the Federal Republic of Germany on imports of raw materials for energy purposes, special importance is given to nuclear energy for reasons of energy policy. Against the background of a nuclear power station capacity amounting to 24,000 MWe in 1976 (power stations being either on order, under construction or actually in operation), the Fast Breeder Reactor (FBR) has quite outstanding significance in this country where the economical utilization both of uranium and of the plutonium

accumulating in light water reactors is concerned. Work in this sector started in the Federal Republic of Germany in 1960. Milestones on the path of development were the initial activities on the plutonium critical SNEAK at Karlsruhe, the successful operation of the KNK 20 MWe experimental reactor (sodium-cooling) with the KNK II (plutonium core) follow-up stage, the construction of the 300 MWe FBR prototype nuclear power station at Kalkar, as well as the initial planning work carried out in connection with a 1,300 MWe FBR demonstration nuclear power station. The provision of a viable infrastructure for safety assessment must go hand in hand with the development of new reactor systems. For this reason, prototype reactors in the Federal Republic of Germany are already subjected to the same strict licensing procedures under nuclear legislation as are commercial nuclear power stations. After several years' practical experience, it is becoming evident that this approach was the right one to take. Already early on, it was recognized in the Federal Republic of Germany that the execution of long-term technological major projects were increasingly exceeding the capacities of unaided development by single nations. The SNR 300 FBR prototype project combines the efforts of the governments, power supply companies, reactor manufacturers and nuclear research centres of the Federal Republic of Germany and of the Kingdoms of both Belgium and the Netherlands.

41405 (LMEC—77-1) **Liquid Metal Engineering Center (LMEC). Annual technical progress report, January—December 1976.** (Liquid Metal Engineering Center, Canoga Park, Calif. (USA)). 15 Mar 1977. Contract EY-76-C-03-0700. 266p. AT.

Information is presented on the development and testing of LMFBR components and systems, including: linear induction EM pump test program; FFTF prototype pump testing; FFTF DHX tube bundle cleaning; friction and wear in sodium; Large Leak Test Rig (LLTR) operations; permanent magnet flowmeter testing; pressure transducer testing; sodium-to-gas leak detection tests; sodium level measurement system testing; CLS/DHX performance; ground-fault interrupter vs. resistance-grounded heater study; copper wire failures on LLTR; and insulating material structural testing.

41406 (ORNL/TM—5681) **Human factors in CRBRP design and planning for safety.** Rubel, P. (Oak Ridge National Lab., Tenn. (USA)). Mar 1977. Contract W-7405-ENG-26. 35p. AT.

Human engineering source and applications literature was reviewed critically to obtain guidance for future efforts to enhance the operability and maintainability of the Clinch River Breeder Reactor Plant (CRBRP). Selected findings were incorporated into recommendations to apply specific human engineering methods at appropriate stages of the CRBRP project. Among the recommendations were (1) to perform analyses of the plant systems conceptual designs in order to identify needs for, and evaluate features of, control and information facilities to cope with defined plant upsets or malfunctions of automatic controls; (2) to apply human engineering design guidelines in arranging control facilities and selecting manual controls and information displays in order to minimize the likelihood of operating errors; (3) to conduct formal reviews of the maintainability features of important systems; and (4) to consider human factors explicitly in the preparation of operating and maintenance procedures and in staff training.

41407 (WARD-CR—3045-15) **Core restraint development. Quarterly progress report for period ending November 30, 1976.** Thompson, D.C. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Jan 1977. Contract EY-76-C-02-3045-005. 29p. Dep. NTIS, PC A03/MF A01.

Progress is summarized in the following areas: three-dimensional development tests, test component friction test, simulated fuel assemblies, instrumented load measurement assemblies, hexagon form verification, facility modification for full-core tests, and TRITON code development. (DG)

41408 (WARD-OX—3045-28) **Fuel-cladding mechanical interaction effects in fast reactor mixed oxide fuel.** Boltax, A.; Biancheria, A. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Jan 1977. Contract EY-76-C-02-3045-007. 40p. AT.

Thermal and fast reactor irradiation experiments on mixed oxide fuel pins under steady-state and power change conditions reveal evidence for significant fuel-cladding mechanical interaction (FCMI) effects. Analytical studies with the LIFE-III fuel performance code indicate that high cladding stresses can be produced by general and local FCMI effects. Also, evidence is presented to show that local cladding strains can be caused by the accumulation of cesium at the fuel-cladding interface. Although it is apparent that steady-state FCMI effects have not given rise to cladding breaches in current fast reactors, it is anticipated that FCMI may become more important in the future because of interest in: higher fuel burnups; increased power ramp rates; load follow operation; and low swelling cladding alloys.

41409 (WARD-RB—3045-14) **Radial blanket design and development. Quarterly progress report for period ending May 31, 1976.** Bishop, E.C. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Dec 1976. Contract EY-76-C-02-3045-004. 96p. AT.

Fabrication and assembly of the 61-rod heat transfer test section has been completed to the point where the test section is ready for installation in the loop. The computer controlled data acquisition system was installed and operationally checked. Preparation of applications programs for acquisition and processing of data is also in progress. Installation of the power supply was completed and work is in progress on the power measurement and current limiting subsystems. Irradiation of the seven-rod radial blanket assembly (WBA-20) continued during cycles 81 and 82 in EBR-II. A first draft of Volume I of the Test Design Description for the Radial Blanket Irradiation experiment in FFTF (WBA-40) was prepared. A draft WBA-40 blanket pellet specification was written as a modification to RDT E13-7T. Analysis of the orifice calibration data was completed and an interim topical report is being prepared. Fabrication and characterization of the mock-up bundle rods was completed. The rods were wire wrapped with 0.37-inch diameter wire and characterized as to wire wrap pitch and rod straightness. Characterization of the compaction rig is in progress. Problems have been encountered with respect to hysteresis in load and motion. Several alternative hydraulic and pneumatic actuators are being considered to determine the system which will yield the lowest hysteresis.

41410 **Burn-out power in once-through tubular steam generators.** pp 280-284 of In International heat transfer conference. Campolunghi, F.; Cumo, M.; Ferrari, G.; Leo, R.; Vaccaro, G. Tokyo; Japan Society of Mechanical Engineering (1974).

From 5. conference on international heat transfer; Tokyo, Japan (3 Sep 1974).

The purpose of this research is to provide experimental data in a design field where existing burn-out correlations are usually extrapolated outside their validity range. Low surface heat fluxes and very long geometries typical of L.M.F.B.R. sodium heated steam generators require full scale water tests. 218 burn-out qualities at pressures ranging from 60 to 160 kg/cm$sup 2$ and specific mass flowrates from 110 to 260 g/cm$sup 2$s have been measured and tested against the most known burn-out correlations. 12 refs.

41411 **Considerations on the use of N_2O_4 as a cooling and working medium in nuclear power plants with fast breeder reactors.** Schilg, G.; Hahn, W. (Tech Univ, Dresden, E Ger). *Wiss. Z. Tech. Univ. Dresden;* **24**: No. 1, 195-204(1975). (In German).

Starting from the state of the art in breeder reactor development, specific features of the use of dissociating gases as cooling and working media are considered. Their advantages consist above all in the extraordinarily good thermophysical properties, due to dissociation processes, which make the attainment of power ratios in the active zone of about 1000 kW/l possible. This enables the realization of the fission material doubling period of less than 7 years possible. Using the chemico-physical characteristics, different circulation processes of the system N_2O_4 in equilibrium $2NO_2$ in equilibrium $2NO+O_2$, which is in chemical equilibrium, are represented in a T,s diagram and discussed. On this basis, the likely dimensions of the main units for an output of 1000 MW of power are determined. The results permit first comparisons to be made with other breeder reactor concepts. 33 refs.

41412 **Simplified inelastic (plastic and creep) analysis of pipe elbows subjected to inplane and out-of-plane bending.** Mello, R.M.; Scheller, J.D. (Westinghouse Electr Corp, Madison, Pa). *Am. Soc. Mech. Eng., [Pap.];* No. 75-PVP-62, vp(1975).

The inelastic analysis of elbows typical of use in Liquid Metal Fast Reactor piping systems is described. Detailed information on stresses, plastic and creep strains, and deformations throughout the elbow bodies resulting from elastic/plastic, elastic/plastic/creep, and elastic/plastic-creep/relaxation material behavior was obtained for the cases of applied inplane and out-of-plane moment loading on the elbows. Some conclusions are made concerning the nature of the resulting stresses in the elbows. The simplified pipe-bend element in the MARC nonlinear finite element program is used as the analytical tool. This element permits nonlinear analysis of piping elbows and pipeline systems at realistic cost. 16 refs.

41413 **Design considerations for systems subject to sodium/water reactions.** Galluzzo, N.G.; Bell, C.R.; McFarland, B. (Rockwell Int, Canoga Park, Calif). *Am. Soc. Mech. Eng., [Pap.];* No. 75-PVP-68, vp(1975).

The design conditions of systems subject to sodium/water reactions can be greatly reduced by a judicious selection of important design parameters. Parameters including tee-joint geometry, rupture disk location, accumulator selection, piping configuration and pressure reducing devices are reviewed. The reference system examined is the 70-MWt Expansion Loop of the Sodium Component Test Installation (SCTI). 6 refs.

41414 **Sodium contamination measurement with plugging meter and hydrogen leak detection system.** Hans, R.; Weiss, H.J. (Interat, Bensberg, Ger). *Siemens-Z.;* **49**: No. 1, 49-53(Jan 1975). (In German).

The presence of oxygen and hydrogen in sodium used as a cooling medium in nuclear power stations jeopardizes safe operation of the plant. A certain degree of purity must therefore be maintained. The plugging meter determines the temperature at which solid particles begin to separate from the sodium and makes it possible to determine the dissolved impurities. The hydrogen detection system monitors the system for minor leaks. Nickel membranes permit the hydrogen to be separated from the sodium and measured. The design and mode of operation of the equipment used are described.

41415 New type sodium flow meter for fuel elements in nuclear power stations. Hans, R. (Interatom, Bensberg, Ger). *Siemens-Z.;* **49**: No. 5, 321-324(May 1975). (In German).

The design and mode of operation of an eddy-current flow meter complete with flow rate and temperature sensors are described. Details of the circuit arrangement are given. Detailed reference is also made to the relevant research and development program. Examples of how the new meter can be used and its technical data are given.

41416 Coarse-mesh correction of the finite difference method for neutron diffusion calculations. Kato, Y.; Takeda, T.; Takeda, S. (Hitachi Ltd, Ibaraki, Jpn). *Nucl. Sci. Eng.;* **61**: No. 2, 127-141(Oct 1976).

The study has been undertaken to evaluate an uncertainty in a finite difference method for two-dimensional neutron diffusion calculations and to provide a simple method to eliminate the uncertainty from k$sub eff$, control rod worth, and peak power density. An effect of a condensation of the energy groups is also studied. It is found that errors in k$sub eff$, control rod worth, and peak power density have linear relationships with the square of mesh spacing, and an extrapolation to zero mesh spacing, by using the linear relationships, is possible. When a basic multigroup cross-section set is condensed into a few-group cross-section set, the errors due to the condensation of the cross sections on k$sub eff$ and on control rod worth are shown to have linear relationships with the inverse square of the number of the condensed energy group. These relationships have been confirmed analytically with the application of perturbation theory.

41417 Economical removal of sodium water reaction products (SWRP) from an LMFBR intermediate heat transport system (IHTS). Anand, R.K.; Reynolds, R.G. (GE, Sunnyvale, Calif). *Am. Soc. Mech. Eng., [Pap.];* No. 76-WA/HT-71, 1-5(5 Dec 1976).

The system study concludes that after a sodium-water reaction in an LMFBR power plant, the hot sodium circulation process is an economical and practical method of removing the SWRP from the IHTS. It is proposed that the impure sodium produced by the hot sodium circulation process be purified by a special fast cleanup cold trap design which is shown. The hot sodium circulation process, using the special fast cleanup cold trap, is shown to save a significant amount of downtime during the life of each LMFBR plant. A development program for the recommended process is included.

41418 Heat transfer in tube bundles of heat exchangers with flow baffles induced forced mixing. Aburomia, M.M.; Chu, A.W.; Cho, S.M. (Foster Wheeler Energy Corp, Livingston, NJ). *Am. Soc. Mech. Eng., [Pap.];* No. 76-WA/HT-73, 1-8(5 Dec 1976).

Thermal analysis of shell-and-tube heat exchangers is investigated through geometric modeling of the unit configuration in addition to considering the heat transfer processes taking place within the tube bundle. The governing equations that characterize the heat transfer from the shell side fluid to the tube side fluid across the heat transfer tube walls are indicated. The equations account for the heat transfer due to molecular conduction, turbulent thermal diffusion, and forced fluid mixing among various shell side fluid channels. The analysis, though general in principle, is applied to the Clinch River Breeder Reactor Plant-Intermediate Heat Exchanger, which utilizes flow baffles appropriately designed for induced forced fluid mixing in the tube bundle. The results of the analysis are presented in terms of the fluid and tube wall temperature distributions of a non-baffled and baffled tube bundle geometry.

41419 Structural and thermal-hydraulic design of a sodium heated duplex bayonet tube steam generator. Desaulniers, W.E. Jr.; Betten, P.R. (Combust Eng, Inc, Windsor, Conn). *Am. Soc. Mech. Eng., [Pap.];* No. 76-WA/HT-74, 1-11(5 Dec 1976).

The thickness sizing of a duplex tube and the associated thermal resistance effects on the thermal hydraulic sizing of duplex bayonet tube steam generator units were investigated. Specific sizing results for a 3800-Mwt commercial LMFBR steam supply system are presented. The duplex tube thicknesses have been sized to prevent rupture and buckling according to criteria for ASME Class 1 nuclear components operating at elevated temperatures. These criteria have been reduced to a simple set of design formulas for the duplex tube thicknesses. A discussion of duplex tube interfacial pressures and interfacial thermal conductance is included.

41420 Sodium heated steam generator tube wastage due to water/steam to sodium leaks--theory and correlation. Lee, Y.J.; Eng, K.Y.; Casey, D.F. (GE, Fast Breeder React Dep, Sunnyvale, Calif). *Am. Soc. Mech. Eng., [Pap.];* No. 76-WA/HT-77, 1-12(5 Dec 1976).

In the Liquid Metal Fast Breeder Reactor (LMFBR) development, one of the most important problems is to maintain the safety and reliability of the steam generator. It has been observed that a small water/steam to sodium leak can cause serious damage to the neighboring tubes which is known as the impingement wastage phenomenon. The paper provides an analytical explanation and a correlation of the wastage data for the phenomenon. The analytical model treats the water/steam leak as a simple expanding jet reacting with sodium. The analytical results include reaction radius, average temperature, and NaOH concentration of the steam jet as well as the wastage quantity. From the results, it is found that the ratio between the reaction zone length to the orifice diameter is constant. While the precise analytical evaluation of the wastage rate is too complicated to achieve, the analytical results indicate that the wastage rate is a function of distance between orifice and target, orifice size, and water/steam conditions of the leak. 24 refs.

41421 Heat transfer tests of an electrically heated 7-rod mock-up of an LMFBR radial blanket assembly. Minushkin, B.; Engel, F.C.; Atkins, R.J.; Markley, R.A. (Westinghouse Electr Corp, Madison, Pa). *Am. Soc. Mech. Eng., [Pap.];* No. 76-WA/HT-80, 1-9(5 Dec 1976).

The paper describes a program to experimentally characterize heat transfer performance of LMFBR radial blanket assemblies. In these assemblies heat transfer occurs over a wide range of complex operating conditions. The range and complexity of conditions are the result of the steep power and temperature gradients which are an inherent feature of the blanket region and the power generation level in an assembly which can vary from 20 to 1100 kw. A seven-rod bundle was built and tested. Temperature distributions within the bundle were measured by a three dimensional network of thermocouples, and recorded by a high-speed computer controlled data acquisition system along with flow, power input and pressure drop. Results agreed with analytical predictions of temperature distribution and pressure drop when as-built configuration and dimensions were considered.

41422 Outlet plenum flow stratification studies for the Clinch River Breeder Reactor Plant. Novendstern, E.H.; Woods, M.D.; Andreychek, T.S.; Flannigan, L.J.; Carr, J.A. (Westinghouse Electr Corp, Madison, Pa). *Am. Soc. Mech. Eng., [Pap.];* No. 76-WA/HT-84, 1-7(5 Dec 1976).

The transient temperature behavior during a simulated reactor trip was studied in a 1/3 sector, 0.55 scale model of the reactor outlet plenum of the CRBRP. Buoyancy effects were simulated using water and salt solution. Effects of variations in Richardson number (ratio of buoyancy/inertia forces) and Froude number (ratio of inertia/viscous forces) were evaluated. Effects of geometrical changes of a component in the outlet plenum called the Upper Internals Structure on transient temperature response were studied; both height of the structure and leakage under this component were experimentally varied. The test results confirm that flow stratification occurs in the outlet plenum following a reactor trip. The colder, denser fluid issuing from the core assemblies during the transient fills the lower portion of the plenum while the hotter fluid is trapped in the region above the outlet nozzles.

41423 Post-critical heat flux fouling by system corrosion products in a model sodium heated steam generator. Cohen, P.; Efferding, L.E. (Westinghouse Electr Corp, Madison, Pa). *Am. Soc. Mech. Eng., [Pap.];* No. 76-WA/NE-12, 1-4(5 Dec 1976).

In connection with a long-time corrosion test of a one-tube model sodium heated steam generator, detailed thermal and hydraulic data are being collected and analyzed. These data indicate a periodic significant fouling downstream of the critical heat flux region, whereas fouling upstream is very slight, if present at all. The maximum fouling observed correlates with the calculated properties of deposits of system corrosion products observed on the tube surface following shutdown. Observations are continuing and alternate interpretations of the data are being investigated.

41424 Effective boiler feed control for test loops. Schmidt, D.K.; Kardos, Z.L. (Westinghouse Electr Corp, Madison, Pa). *Am. Soc. Mech. Eng., [Pap.];* No. 76-Wa/NE-15, 1-4(5 Dec 1976).

The Clinch River Breeder Reactor Plant (CRBRP) requires that the associated steam generator development testing facility construct an effective water supply having chemical control plus system monitoring to support a small inventory test loop. A pretreatment feed water system that chemically controls an ultra critical flow-through test loop was developed for the CRBRP sodium heated steam generator model test (0.27 MWt). The test parameters require very stringent control of the water supply including comprehensive chemical analyses plus on-line system monitoring of the aqueous steam generator side. A detailed discussion of the chemical control requirements and design considerations is presented along

with specific analytical techniques and potential larger system applications.

41425 Reliability analysis of the decay heat removal system of a 1000-MW(e) gas-cooled fast breeder reactor. Bittermann, D. (Kraftwerk Union AG, Erlangen, Ger.); Wehling, J. *Nucl. Technol.;* **32**: No. 3, 247-256(Mar 1977).

A reliability analysis for the decay heat removal system of a 1000-MW—(e) gas-cooled fast breeder reactor (GCFBR) has been carried out. ITT relates only to the GCFBR specific systems required after the maximum depressurization accident, and normal shutdown. Non-GCFBR specific systems such as the electrical supply system and the containment back-pressure system were not included in the analysis. For these analyses, the method of fault trees was used to describe the different failure combinations of the system. The calculations were performed with the system analysis program SAP-1, which combines analytical and simulation methods to find the failure probability and the unavailability of the system. The results of the analysis show that the unavailability governs the reliability of the system; a computed value of 3×10^{-4} was obtained for the unavailability of the system after a maximum depressurization accident, and a value of 4×10^{-6} was obtained for the unavailability of the system after normal shutdown.

41426 Sodium purification by cold trapping at the Experimental Breeder Reactor II. Holmes, J.T.; Smith, C.R.F.; Osterhout, M.M.; Olson, W.H. (Argonne National Lab., Idaho Falls, ID). *Nucl. Technol.;* **32**: No. 3, 304-314(Mar 1977).

Purity control of the primary and secondary sodium systems at the Experimental Breeder Reactor II (EBR-II) is by essentially continuous cold trapping of small side streams of the total sodium inventories. The EBR-II cold traps are effective for the control of the major chemical impurities, i.e., oxygen and hydrogen (and also tritium). The trapping effectiveness is higher for hydrogen (NaH) than for oxygen (Na_2O). The trap on the primary sodium system is more effective than the secondary cold trap because of higher sodium velocities and, probably, longer residence times in the crystallization zone of the primary trap. Radioisotopes such as ^{131}I and ^{137}Cs are not effectively trapped. New control methods may be required for these and other radioisotopes to allow the continued use of direct maintenance procedures for various plant systems.

POWER REACTORS, AUXILIARY, MOBILE, PACKAGE, AND TRANSPORTABLE

41427 (PB—258232) **Mobile nuclear power plants: initial feasibility study. Research report.** Jones, D.W. (Memphis State Univ., Tenn. (USA). Center for Nuclear Studies). May 1976. 39p. NTIS $4.50.

This study addresses an alternate method for the utilization of nuclear energy which could satisfy industrial energy needs in areas of our nation where primary fuels and other energy resources are not available and which could provide energy for the development of American industry abroad. This alternative is cost competitive with oil and some forms of coal and will provide both steam and electrical power at industrial plant sites. Both technical and economic feasibilities of this energy resource are described, and a program is outlined for its development. Recommendations are also made that a demonstration project be started to establish the feasibility of this alternative.

41428 Electric power-conditioning for a thermionic generator. Kleinkauf, W. Stuttgart; Institute fuer Energiewandlung und Elektr Antriebe (1975). 125p. (In German).

The design and the experimental investigations of a power-conditioning system for a satellite incore-thermionic reactor (d-c generator) with 20 kW electric power output is described. The main subsystems are an electronically controlled bypass for high leakage power and a three-phase high-current inverter. A special a-c voltage filter is considered for optimal reduction of harmonics. Computations of the fundamental frequency are presented which allow the weight of the total power unit to be minimized. 39 refs.

REGULATION AND LICENSING

41429 (DOCKET-50245—956) **Millstone Nuclear Power Station, Unit 1. Annual operating report: 1 January—31 December 1976.** (Northeast Nuclear Energy Co., Hartford, Conn. (USA)). 28 Feb 1977. 45p.

Net electrical power generated was 3,752,445 MWh with the generator on line 6,682 hrs. Information is presented concerning operations; shutdowns and power reductions; refueling; maintenance; failed fuel elements; power generation; occupational personnel radiation exposure; and changes in technical specifications, plant design, and key supervisory personnel. (FS)

41430 (DOCKET-50254—1006) **Quad-Cities Station, Units 1 and 2. Annual operating report for 1976.** (Commonwealth Edison Co., Chicago, Ill. (USA)). 1976. 154p. (DOCKET-50265—975).

Net electrical power generated by Unit 1 was 3,393,062 MWH with the generator on line 5,703.0 hrs. Unit 2 generated 4,304,684 MWH with the generator on line 7,145.3 hrs. Information is presented concerning modifications, maintenance, power generation, shutdowns, occupational radiation exposures, and organization. (FS)

41431 (DOCKET-50271—917) **Vermont Yankee Nuclear Power Station. Annual operating report: January—December 1976.** (Vermont Yankee Nuclear Power Corp., Rutland (USA)). 28 Feb 1977. 2p.

Net electrical energy generated was 3,260,016 MWH with the facility on line for 6,776 hrs. Information is presented concerning operation, procedure changes, tests, experiments, plant changes, corrective maintenance, license event reports, forced power reductions, shutdowns, personnel radiation exposures, use of chemicals, plant discharges, cooling tower blowdown, traveling screens, fish impingement, reactor start-up, scram reports, and primary coolant chemistry. (FS)

41432 (DOCKET-STN-50580—1) **Erie Nuclear Plant, Units 1 and 2. License application, preliminary safety analysis report, volume 1: chapter 1.** (Ohio Edison Co., Akron (USA)). 28 Feb 1977. 375p. (DOCKET-STN-50581—1).

Erie 1 and 2 reactors will be located on a site consisting of 1,740 acres in Berlin Township about 2.4 miles south of Lake Erie and 8.9 miles southeast of Sandusky, Ohio. Lake Erie will provide makeup water. The ultimate heat sink will be a 40 acre cooling reservoir shared by both units. Each unit has a proposed core thermal power level of 3,760 MW(t) and a nominal net capacity of about 1282 MW(e). Unit 1 is scheduled for commercial operation by 4/1/84 and Unit 2 by 4/1/86. Fuel will be Zircaloy-4 clad tubes containing cylindrical fuel pellets of UO_2. B and W pressurized water reactor units to be employed are described in DOCKET-STN-50561. (FS)

41433 (NTISUB/B—124-76/010) **Monthly inspection summary report.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Inspection and Enforcement). Oct 1976. 70p. (NUREG—0025-10). NTIS $4.00.

See also NTISUB/B/124-76/009.

The scope and findings of inspections and investigations made by the Nuclear Regulatory Commission (NRC) are summarized in a monthly report. These include NRC reports on nuclear power reactors under construction or in operation. Information on individual facilities is presented, including such items as non-compliance with regulations, abnormal occurrence reviews, plant status and, for plants under construction, implementation of quality assurance audits. (GRA)

41434 (PB—254804-T/SL) **Recommendations of the Reactor Safety Commission, 1971—1974.** (Technischer Ueberwachungs-Verein Rheinland e.V., Koeln (Germany, F.R.)). Dec 1975. Translation of unidentified German language monograph. (IRS-A—9). 208p. NTIS $7.75.

This translation from the German compiles the recommendations of the Reactor Safety Commission published in the Federal Gazette over the period 1971-1974 for protection of the population from possible dangers occurring from the peaceful use of nuclear energy and in all matters of the safety of nuclear-oriented installations, including tasks evolving from atomic legal licensing procedures. This report was prepared for the Federal Minister of the Interior through the Office of the Reactor Safety Commission assigned to the Institute for Reactor Safety of the Technical Inspection Association in Cologne, Germany.

41435 (PB—255418) **Licensee contractor and vendor inspection status report. Quarterly report.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Inspection and Enforcement). 30 Jun 1976. 156p. (NUREG—0040-02). NTIS $6.75.

A fundamental premise of the Nuclear Regulatory Commission's nuclear facility licensing and inspection program is that the licensee is responsible for the proper construction and safe operation of his nuclear power plant. The NRC inspects to determine whether its requirements are being met by the licensee and his contractors. The licensee is responsible for developing a detailed quality assurance plan as part of his license application. This plan includes the quality assurance programs of the licensee's contractors and vendors. The NRC reviews the licensee's and contractor's quality assurance plans to determine that implementation of the proposed quality assurance program would be satisfactory and responsive to NRC regulations. In addition to providing information on inspection results, this Licensee Contractor and Vendor Inspection Status Report - the 'White Book' - contains information submitted by licensees in accordance with NRC rules and regulations covering events attributed by the licensee to design deficiencies and

equipment malfunctions. These licensee event reports which cover one calendar quarter identify both the vendor and the organization responsible for the procurement and/or design document.

41436 (PB—258385) **Standard technical specifications for General Electric boiling water reactors.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Nuclear Reactor Regulation). Oct 1976. 305p. (NUREG—0123). NTIS $9.75.

The General Electric (GE) Standard Technical Specifications addresses the categories required by 10 CFR 50 and consists of six sections covering: Definitions, Safety Limits and Limiting Safety System Settings, Limiting Conditions for Operation, Surveillance Requirements, Design Features, and Administrative Controls. This Standard Technical Specifications package has been structured for use on GE BWR-4 Nuclear Steam Supply System plants being reviewed for an Operating License. (GRA)

41437 (RDT-E—6-33T) **Control rod assembly for liquid metal fast breeder reactors.** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Reactor Development and Demonstration). Mar 1977. Contract W-7405-ENG-26. 14p. RSO.

This standard establishes the requirements for fabrication, testing, and inspection of control rod assemblies for use in liquid metal fast breeder reactors.

ECONOMICS

41438 (IAEA-CN—36/337) **Structure of atomic power industry with allowance for energy production other than electricity.** Aleksandrov, A.P.; Legasov, V.A.; Sidorenko, V.A.; Ponomarev-Stepnoj, N.N.; Protsenko, A.N.; Grebennik, V.N.; Glushkov, E.S. (International Atomic Energy Agency, Vienna (Austria)). 1977. 10p. (In Russian). (CONF-770505—237). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

1.B.1.P.1./04 3 figs. Also available in English.

The important tendency in the development of nuclear power is broadening the scope of its application for substitution of mineral fuel by nuclear not only in electrical power production but in other energy consuming fields of industry. The development of large-scale nuclear power plants permits the provision of the significant part of energy supply of all kinds and saves on oil and gas. Scales and rates of development of nuclear power are estimated for the model society on the basis of predicted energy consumption per capita. The possible rates and scales of nuclear power development are determined at some alternative amounts of potential reserves of organic fuel (oil, gas) per capita and within the economically and ecologically reasonable scales of coal utilization. An analysis is given of possible scopes of application of nuclear power industry: for production of electricity, central heating, hydrogen generation, gasification of coals, metallurgy, chemistry by means of medium- and high-temperature reactors. The relation between electrical energy and heat production in energetics and the nuclear power industry and the dynamics of change in this relation is examined. The promising development of high temperature helium reactors is discussed. Considerations on possible effect of thorium cycle on the structure of nuclear power industry are outlined.

41439 (INIS-mf—3391, pp 106-116) **Research programs in nuclear technology.** Drahny, M. (Vyzkumny Ustav Energeticky, Prague (Czechoslovakia)). Jun 1975. (In Czech).

From 10. meeting of Czechoslovak power engineers; Kosice, Czechoslovakia (4 Jun 1975).

In Electric power base constructio. Part I.

Certain aspects of nuclear power production and of its inclusion in the power economy are described. The main trend of research and development work is derived.

41440 (K/CSD—3) **Monte Carlo error analysis of power plant capital cost calculations.** DeLozier, R.C. (Oak Ridge Gaseous Diffusion Plant, Tenn. (USA)). Apr 1977. Contract W-7405-ENG-26. 81p. Dep. NTIS, PC A05/MF A01.

A Monte Carlo statistical code is coupled with the CONCEPT capital cost estimating program to illustrate the accuracy of the cost estimates. The CONCEPT program is used to estimate the capital cost of nuclear and fossil-fueled power plants. Knowing the accuracy limitation of these estimates is important for decision-making. This analysis was made only on nuclear (PWR) type power plants in the South. However, the intent of the study was only to indicate the method of analysis, not to be a detailed sensitivity analysis of all parameters.

41441 **Advisability of nuclear energy: analysis from the point of view of the electric generating system.** pp 895-915 of In Conference on long-term prospects of the electric power supply situation. Vol. II. de Cruz Filipe, R. Stockholm; Statens Vattenfallsverk (1973). (In French)

From Conference on long-term prospects of the electric power supply situation; Stockholm, Sweden (11 Sep 1972).

The Portuguese electric power production system is analyzed with a view to optimal long-term programming of production costs, with an attempt to quantify the benefits connected with timing the introduction of nuclear energy. 5 refs.

41442 **South Africa's nuclear energy analysis.** *Nucl. Eng. Int.;* **20**: No. 225, 111-115(Feb 1975).

South Africa's commitment to commencing a nuclear power programme with an order for its first LWR station during 1976 can be judged by the country's recent successful attempt to clinch a uranium enrichment contact with the U.S.AEC. This was to provide fuel for the first of two 800 to 1000 MW(e) units to be built at ESCOM's Koeberg site for operation in 1983. The economic analysis leading to this strategy has been explained in the latest of three study reports by the Atomic Energy Board in collaboration with the Electricity Supply Commission--"A brief examination of the status of nuclear power in the Republic using 1974 costs."

41443 . $\sigma\Sigma_8\gamma_{73}\omega\ \bar{}\Lambda'_7\omega\ \bar{}\gamma_3\Omega\pi\mu$: $_3\Omega\ _3\gamma\pi_7\omega\Omega_3\pi^+\Xi_7\ _8\Lambda\omega\ \gamma_3\omega_{97}\ _5{}^+\pi^+{}_7\mu$. $\sigma\Lambda\omega_8\mu\pi\omega\Lambda\Delta$, ∞.; $<_3\gamma\gamma_7\Omega_{47}\omega_9$, ∞. $+\int$ - $\vee^+{}_6\mu\beta\omega$. $+_3\omega\Delta_7$, $+_7\Omega\pi$., $\int_3\Omega^+\pi$.; ^{46}. $\sigma\Lambda$. ^{5}, $_{35_37}$, $_{41_42}(\upsilon_3$. $\int'_{76}{}^+\mu=)$.

The advantages and drawbacks of electric power generation in nuclear power plants as compared with conventional thermal power plants are discussed. It is concluded that nuclear power plants can be recommended as a good alternative for supplying major cities with electric power.

FUEL CYCLE

REFER ALSO TO CITATION(S) 41093

41444 (IAEA-CN—36/353) $\approx\gamma\Sigma\pi\Lambda\Omega^+\Sigma\Delta\ _8\Sigma_7\gamma\ _3\Omega_6\ _8\Sigma_7\gamma\ _7\gamma_7\Delta_7\Omega\pi\mu\ _8\Lambda\omega\ \bar{}\Lambda'_7\omega\ \omega_{735}\pi\Lambda\omega\mu$. $_{23}{}^+\Delta\Lambda\Xi\mu\beta^{++}$, $\cong$. $\int$.; $\partial\Lambda\gamma\Lambda\Xi\Omega^+\Omega$, κ. $\int$.; $\upsilon_7\Omega$'shikova, T.S.; Agapova, N.P.; Bibilashvili, Yu.K.; Tsykanov, V.A.; Davydov, E.F.; Gryazev, V.M.; Syuzev, V.N.; Kuz'min, V.I. (International Atomic Energy Agency, Vienna (Austria)). 1977. 14p. (In Russian). (CONF-770505—146). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.5.-.T.2./04 5 figs.

The paper discusses the problem of plutonium accumulation in thermal reactors in accordance with the programme of the development of nuclear energetics in the USSR. General considerations are presented on the use of plutonium fuel in thermal and fast reactor fuel elements. The results are given of the investigations on the development of uranium - plutonium base fuel elements for fast power reactors including experimental data on the BOR- 60 reactor irradiation of fuel elements to high burn-ups. General aspects are considered of the technology of fuel element fabrication and the discussion is made of basic features inherent in technological processes. The discussion is made of the state and prospects of spent fuel elements reprocessing to recover plutonium.

41445 (IAEA-CN—36/477) **Plutonium use - present status and perspectives.** van Dievoet, J.; Fossoul, E.; Jonckheere, E.; van den Bemden, E. (International Atomic Energy Agency, Vienna (Austria)). 1977. 11p. (In French). (CONF-770505—135). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.A.1.P.1./03 2 tables, 1 fig.

The recycling of plutonium is a well-known technique today and the objections which could be raised against it hardly stand up to analysis. Utilization of plutonium offers an appreciable saving in terms of uranium and separative work units, the consumption being of a low order of magnitude in comparison with the total amount of plutonium needed for the eventual fabrication of the first fast reactor cores. It can also be shown that immediate reprocessing of the recycling fuel is not essential for the economics of the concept. Temporary storage of recycled fuel has the advantage of concentrating plutonium in a particularly safe form, namely in irradiated plutonium-bearing fuel assemblies. Lastly, recycling offers such flexibility that it does not in practice represent an obstacle to fuel management at power plants with light-water reactors. Also for this reason, the option of recycling can be adopted only for a certain time, while awaiting a better use of plutonium in fast reactors, especially plutonium which has been once recycled in a thermal reactor and has been depleted there. Apart from the techno-economic aspects, the plutonium industry has to face extremely important problems in connection with safety - safety of personnel, safety of the environment, and safeguards associated with efficient protection of special materials. Handling of plutonium is only a segment of the fuel cycle, whose own safeguards problems differ little from those of the reprocessing facility operator. A particularly sensitive point

undoubtedly arises in connection with transport. In this respect there is increasing interest in the establishment of integrated centres where the location of the reprocessing plant producing plutonium side by side with the fabrication plant recycling this plutonium considerably reduces the safeguards problems associated with the transport of plutonium.

41446 **Simulation methods for nuclear production scheduling.** Miles, W.T.; Markel, L.C. (Syst Control Inc, Palo Alto, Calif). pp 579-583 of In Proceedings of the 14th conference of the Institute of Electrical and Electronics Engineers. New York; Inst. of Electrical and Electronics Engineers (1975).

From 14. conference of the Institute of Electrical and Electronics Engineers; Houston, TX, USA (10 Dec 1975).

The paper reviews some of the recent developments and applications of simulation methods for use in nuclear production scheduling and fuel management. Emphasis is placed on the various formulations and approaches to the mid-range planning problem, whose objective is the determination of an optimal (least cost) system operating strategy over a multi-year planning horizon. The decomposition of the mid-range problem into power system simulation, reactor core simulation and nuclear fuel management optimization, and system integration models is discussed.

PROCESS HEAT REACTORS

REFER ALSO TO CITATION(S) 40788, 41161

41447 (IAEA-CN—36/52) **Near term feasibility of nuclear reactor for sea-water desalting; coupling of standard condensing nuclear power stations to low grade heat multieffect distillation plants.** Adar, J.; Manor, S.; Schaal, M. (International Atomic Energy Agency, Vienna (Austria)). 1977. 9p. (CONF-770505—236). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

7.2.-.T.1./06 1 fig., 1 table.

Commercial nuclear power reactors exist only in standard sizes and designs. No large nuclear back-pressure turbines are available today. Therefore, near term large scale nuclear desalination plants must be tailored to the NSSS sizes and available turbines and not the contrary. Standard condensing nuclear turbines could operate continuously with a back-presure of up to 5-7" Hg (depending on the supplier). It means that they can exhaust huge amounts of steam at 56°C - 64°C with a loss of electricity production of 6% - 10% when compared to 2 1/2" Hg normal condensing pressure. The horizontal aluminium tube multi-effect distillation process developed by Israel Desalination Engineering Ltd. is suitable for the use of such low-grade heat: 4 to 9 effects can operate within these temperature ranges. A special flash-chamber constitutes a positive barrier against any possible contamination being carried over by the steam exhausted from the turbine to the desalination plant. Flow sheets, heat and mass balances have been prepared for two standard sizes of NSSS and turbines (1882sup(Mwth) and 2785sup(Mwth)), two "back-pressures" (5 1/2" and 7" Hg), and corresponding desalination plants. Only standard equipment is being used in the steam and electricity producing plant. The desalination plant consists of 6 to 12 parallel double lines, each of them similar to a large prototype now being designed and which is going to be coupled to an old fossil power station. Water production varies between 50 and 123 sup(us MGD) and water cost between 23 and 36 sup(cents)/M^3. Total energy requirements of the desalination plant represent only 19 to 50% of the total water cost as against 75% for a single purpose plant. Costs are based on actual bids for the power plant and actual estimates for the desalination prototype. The operation is designed to be flexible so that the power plant can be operated either in conjunction with the desalination plant, or as a single purpose plant.

41448 (IAEA-CN—36/275) **Reactor waste heat utilization and district heating reactors. Nuclear district heating in Sweden - Regional reject heat utilization schemes and small heat-only reactors.** Hannerz, K.; Larsson, Y.; Margen, P. (International Atomic Energy Agency, Vienna (Austria)). 1977. 8p. (CONF-770505—148). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

8.0.-.T.1./09 6 figs.

A brief review is given of the current status of district heating in Sweden. In future, district heating schemes will become increasingly interesting as a means of utilizing heat from nuclear reactors. Present recommendations in Sweden are that large reactors should not be located closer than about 20 km from large population centres. Reject heat from such reactors is cheap at source. To minimize the cost of long distance hot water transmission large heat rates must be transmitted. Only areas with large populations can meet this requirement. The three areas of main interest are Malmoe/Lund/Helsingborg housing close to 0.5 million; Greater Stockholm housing 1 to 1.5 million and Greater Gothenburg housing about 0.5 million people. There is an active proposal that the Malmoe/Lund/Helsingborg region would be served by a third nuclear unit at Barsebaeck, located about 20 km from Malmoe/Lund and supplying 950 MW of base load heat. Preliminary proposals for Stockholm involve a 2000 MW heat supply; proposals for Gothenburg are more tentative. The paper describes progress on these proposals and their technology. It also outlines technology under development to increase the economic range of large scale heat transport and to make distribution economic even for low heat-density family housing estates. Regions apart from the few major urban areas mentioned above require the adoption of a different approach. To this end the development of a small, simple low-temperature reactor for heat-only production suitable for urban location has been started in Sweden in close contact with Finland. Some results of the work in progress are presented, with emphasis on the safety requirements. An outline is given in the paper as to how problems of regional heat planning and institutional and legislative issues are being approached.

41449 (IAEA-CN—36/338) **Use of nuclear reactors for central heat supply and district heating.** Baturov, B.B.; Melent'ev, L.A.; Bulkin, Yu.M.; Galaktionov, I.V.; Zvereva, G.A.; Tokarev, Yu.I.; Chernyaev, V.A.; Smirnova, E.S. (International Atomic Energy Agency, Vienna (Austria)). 1977. 18p. (In Russian). (CONF-770505—242). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

7.2.-.T.1./08 3 figs. Also available in English.

The report deals with the analysis of economic factors and engineering effectiveness of the use of nuclear reactors for centralized industrial and municipal heat supply. The report gives the appraisal of comparative economic effectiveness of the use of nuclear heat sources for centralized industrial and municipal heat supply, taking into consideration system effects that arise with their use in power engineering of a large industrial region. Possible changes in the volume of organic fuel, capital investments, and accounting cost necessary to satisfy the fixed needs of the said region in heat and electric energy with the addition of nuclear sources of centralized heat supply to power engineering are analyzed. Also presented is the evaluation and analysis of the permissible rate of specific capital investment for the construction of nuclear heat sources, such that they may compete with the traditional sources. Different types of nuclear reactors and plants for combined power generation and district heating are considered.

41450 (IAEA-CN—36/376) **Production of refined intermediate fuels with high temperature reactors.** Nowacki, P.J. (International Atomic Energy Agency, Vienna (Austria)). 1977. 20p. (CONF-770505—174). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

8.0.-.T.1./06 2 tables, 7 figs. Also available in French.

Power plants can be divided into conventional steam plants, fueled with hard coal, lignite or liquid fuel, hydroelectric plants and nuclear plants, their chief use was or is the production of electric energy and - in certain cases only - of production of process heat, using steam or hot water for process heat in industry and district heating for residential and commercial purposes. The part played by electricity in the whole energy demand is of the order of 10% to 25% the total demand, the rest is necessary for supplying process heat below 200°C or above 200°C, up to some 1500°C. Manmade fuels, whether in a gaseous or liquid phase, contain hydrogen, and one can believe, the world is entering a new energy civilisation in utilizing hydrogen and its compounds as second energy vector. The author has taken up the task to investigate this new problem of process, heat in the form of hydrogen and its compounds, by evaluating their present and future production, based on the utilization of natural gas, oil coal, water and the nuclear heat of helium, available in a closed circuit as primary coolant in a high-temperature helium cooled reactor. The paper deals in more detail with the following application of Nuclear Heat: hydrogasification, direct reduction of ore, mainly iron ores, ammonia synthesis, methanol synthesis Hydrocracking, long distance transfer of process heat (chemical heat pipe), hydrogenation of coal, Fischer - Tropsch synthesis, oxosynthesis, coal gasification, coal liquefaction, water splitting (thermolysis) and electrolysis. The various chemical reactions are discussed. Economic and geographical distribution of various kinds of process heat are briefly discussed.

41451 (IAEA-CN—36/465) **Experimental study of utilization of nuclear power heating plants for big towns and industrial agglomerations in Russia.** Barabas, K.; Neumann, J. (International Atomic Energy Agency, Vienna (Austria)). 1977. 11p. (CONF-770505—240). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

7.2.-.T.1./08 Also available.

The paper describes comparison of nuclear power heating plants with an output corresponding to 1000 MWe with plants of the same output using coal or oil. The economical aspects are compared, both as regards investment and operation costs. As to environmental aspects the comparison is performed concerning pollutions into atmosphere by exhalations and gaseous emissions and also as to thermal pollutions into hydrosphere and atmosphere. Basic schemes of a nuclear power plant with two PWR's, each having an output of 1500 MWt, are described. The plant supplies, beyond electric power, also heat both for technological purposes of factories and for municipal heating systems (appartments, shops and other auxiliary municipal facilities). At the same time the basic heat-flow diagram of a nuclear power heating plant is stated, inclusive of relative losses. The study emphasizes possible utilization of waste heat for heating of glass houses of 200 sq. m area both for growing of vegetables and of some sorts of flowers for seeds and for production of fish. As to possibilities of utilizing waste heat, the needs of a big town (or of an industrial agglomeration) are taken into consideration, in vicinity of which the nuclear power heating plant is located.

41452 (TRINEC-P—926) **Uses of nuclear energy in metallurgy - research and development.** (Trinecke Zelezarny (Czechoslovakia)). 15 Aug 1974. 7p. (In Czech). Dep. NTIS (US Sales Only), PC A02/MF A01.

Translated from Steel Today and Tomorrow (Mar 1974) No. 3, p. 8-9. Available from Trinecke Zelezarny, Trinec, Czechoslovakia.

Metallurgy is one of the biggest energy consumers. Saving fossil fuels for other than power uses and the endeavour to improve the living environment are the main motivations for efforts to use nuclear energy in iron and steel production. The possibilities are considered of the use of high-temperature gas cooled reactors as heat sources for metallurgy and examples of such procedure in Japan are given.

NUCLEAR REACTOR TECHNOLOGY

THEORY AND CALCULATION

41453 (CS-INIS—30) **Turbulent temperature and pressure pulsations in longitudinal flow through rod bundles.** Kadlec, J.; Lang, W. (Atomova Elektraren Bohunice, Jaslovske Bohunice (Czechoslovakia)). [nd]. 5p. (In Slovak). (P—675). Dep. NTIS (US Sales Only), PC A02/MF A01.

The results are summed up of the experimental research of turbulent statistical characteristics in the boundary layer at coolant flow in rod bundles spaced by grids. Measuring techniques are described. Hydrodynamical variables were measured in water, temperature pulsations were measured in sodium. The principal objective of this research was to obtain data on the hydrodynamical sources of fuel rod vibration. It also yielded interesting data on the structure of turbulent flow and on the mechanism of heat transfer in rod bundles.

41454 (N—76-30046) **Plasma core reactor simulations using RF uranium seeded argon discharges.** Roman, W.C. (United Technologies Research Center, East Hartford, Conn. (USA)). Jul 1976. Contract NAS1-13291. 45p. (NASA-CR—2719). NTIS $4.00.

Experimental results are described in which pure uranium hexafluoride was injected into an argon-confined, steady-state, RF-heated plasma to investigate characteristics of plasma core nuclear reactors. The 80 kW (13.56 MHz) and 1.2 MW (5.51 MHz) rf induction heater facilities were used to determine a test chamber flow scheme which offered best uranium confinement with minimum wall coating. The cylindrical fused-silica test chamber walls were 5.7-cm-ID by 10-cm-long. Test conditions included RF powers of 2-85 kW, chamber pressures of 1-12 atm, and uranium hexafluoride mass-flow rates of 0.005-0.13 g/s. Successful techniques were developed for fluid-mechanical confinement of RF-heated plasmas with pure uranium hexafluoride injection. (Author) (GRA)

41455 (PB—255169) **Light-water reactor physics parameters for transient analysis. Final report 1 Jul 74—30 Jun 75.** Olmos, J.; Hansen, K.F. (Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.). Jun 1975. 36p. (MIT-EL—75-022). NTIS $4.00.

The nature and characteristics of nuclear reactor transients induced by control rod motions are important to light-water reactor safety analyses. Rod motion influences both local neutron absorption rates and the local neutron spectra. Studies on specific systems suggest that accurate prediction of transients requires that both the absorption rate change and the spectral change are necessary to represent control rod motion. (GRA)

41456 (PB—255405) **'STEALTH' a Lagrange explicit finite-difference code for solids structural, and thermohydraulic analysis. Technical report.** Hofmann, R. (Science Applications, Inc., Oakland, Calif. (USA)). Jun 1976. 84p. (TR—1). NTIS $5.00.

A useful computer simulation method based on the explicit finite-difference technique can be used to address transient dynamic situations associated with nuclear reactor design and analysis. An introduction to explicit finite-difference technology, the theoretical background (physical and numerical) a review of some explicit codes, a discussion of nuclear reactor applications, and a brief description of EPRI's STEALTH codes are presented. STEALTH computer code manuals are available which describe the numerical equations, programming architecture, input conventions, sample and verification problems, and plotting system. The STEALTH codes are based entirely on the published technology of the Lawrence Livermore Laboratory (LLL), Livermore, California, and Sandia Laboratories, Albuquerque, New Mexico.

41457 (PB—255548) **A review of the rational approach to two-phase flow modeling. Topical report.** Stuhmiller, J.H. (JAYCOR, Del Mar, Calif. (USA)). Jul 1976. 61p. NTIS $4.50.

The rational approach to two-phase flow modeling is reviewed. An attempt is made to contribute to this field by providing an intuitive explanation of many of the abstract mathematical results, by identifying subtleties of two-phase flow modeling that demand special consideration, and by indicating a systematic way in which an understanding of two-phase flow dynamics can be gained.

41458 (UJV—3778-R) **Local hydrodynamic characteristics of regular triangular lattice of rods.** Mantlik, F.; Hejna, J.; Cervenka, J. (Ustav Jaderneho Vyzkumu, Rez (Czechoslovakia)). Jun 1976. 44p. (In Russian). Dep. NTIS (US Sales Only), PC A03/MF A01.

Results are presented of an experimental investigation of the friction factor, velocity fields, and shear stress distribution around a wetted perimeter in a rod bundle of a triangular lattice with a pitch-to-diameter ratio of 1.17. Measurements were made on 19-rod aerodynamical model at the Reynolds number of 42 300 and 211 000. The results indicated a highly significant effect of secondary flow.

41459 **Two-dimensional transient flow analysis of a pipe-elbow loop by finite-differences.** Abdel-Moneim, M.T.; Chang, Y.W. (Argonne Natl Lab, Ill). *Am. Soc. Mech. Eng.*, [*Pap.*]; No. 75-PVP-69, vp(1975).

A two-dimensional mathematical model that describes the transient flow in an elbow of a circular cross-section in terms of the r and $theta$ coordinates and ignores the motion of the fluid normal to the r-$theta$ plane is considered to approximate the flow in an elbow of any angle. The equations developed are solved numerically using the finite-difference method as applied to the basic Implicit Continuous-Fluid Eulerian (ICE) technique. The elbow model is incorporated with the two-dimensional circular pipe model in one computer code that is capable of analyzing the transient compressible flow of fluids in a loop consisting of straight pipes and elbows of any angle connected in series and subject to two different pressure pulses P(t) at both ends. The pipe walls can be either rigid or elastic-plastic walls, while those of the elbows can only be rigid. 9 refs.

41460 **Transmutation of strontium-90 and cesium-137 in a high-flux fast reactor with a thermalized central region.** Taube, M. (Fed Inst for React Res, Wurenlingen, Switz). *Nucl. Sci. Eng.*; **61**: No. 2, 212-221(Oct 1976).

The fission products $sup 90$Sr and $sup 137$Cs produced by fission reactors of 30 GW(th) can be transmutated into stable nuclides by neutron irradiation with a thermal flux of 2*10$sup 16$ n cm$sup -2$s$sup -1$. The rates of transmutation are 15 and 3.3 times greater, respectively than that of spontaneous beta decay. The transmutation would take place in a central thermalized region of a high-flux fast burner reactor of 7 GW(th). In the case where the power reactors of 23 GW(th) are breeders with a high breeding gain of G=0.38, the total system, inclusive of the high-flux burner, remains a breeding system with G(total)=0.09. Details of the neutronics calculations and simplified thermohydraulics are given.

41461 **Solution of the fuel burnup control problem with a controlling neutron equation and Walsh functions.** Koga, R. (Kyoto Univ, Uji, Jpn). *Nucl. Sci. Eng.*; **61**: No. 2, 239-249(Oct 1976).

A burnup control problem during a reactor core life is considered and solved by making use of a neutron-governing equation that is particularly devised to fit power reactors. Space-dependent parameters are expanded using Walsh functions, and the burnup process is described in terms of the expansion coefficient. By applying the Walsh-function expansion to a newly devised neutron-governing equation, CUMULUS, the criticality condition is established through a more simplified approach, and the system structure of a two-region reactor can be illustrated graphically. Using the above burnup model, an optimal control problem to maximize the average burnup at the end of a core life is considered, and numerical test problems are solved.

41462 **Groupwise rebalancing technique for integral transport problems.** Cheng, H. (Brookhaven Natl Lab, Upton, NY). *Nucl. Sci. Eng.*; **61**: No. 2, 258-261(Oct 1976).

An efficient groupwise rebalancing technique for accelerating the iterative solution to the integral transport equation is described, and the results obtained for a number of unit cell problems with the lattice analysis code HAMMER are presented to demonstrate its efficiency. For light water reactor lattices, a factor of 2 or more saving in central processor unit time of the CDC 7600 computer was observed.

41463 Two-dimensional calculation of a pulse propagation experiment. Christens, J.M.A.; Parks, P.B.; Diaz, N.J. (DuPont, Aiken, SC). *Nucl. Sci. Eng.;* **61**: No. 2, 261-267(Oct 1976).

Excellent agreement has been found between a University of Florida neutron pulse propagation experiment and a two-dimensional space-time calculation. Discrepancies previously reported between the experiments and one-dimensional WIGLE calculations are now attributed to inadequate treatment of the kinetic distortion caused by the presence of transverse reflectors.

41464 Laminar-flow pressure drop in symmetrical finite, rod bundles. Zarling, J.P. (Univ of Alaska, Fairbanks). *Nucl. Sci. Eng.;* **61**: No. 2, 282-285(Oct 1976).

Laminar-flow pressure drop in the form of f*Re is presented for rod bundle geometries consisting of a central rod surrounded by four to ten peripheral rods within a containing channel. The influence of varying rod size and peripheral rod circle diameter on the pressure drop has also been reported.

COMPONENTS AND ACCESSORIES

REFER ALSO TO CITATION(S) 41813

41465 (BNL-NUREG—50615) **Assessment of non-linear analysis finite element program (NONSAP) for inelastic analysis.** Chang, T.Y.; Prachuktam, S.; Reich, M. (Brookhaven National Lab., Upton, N.Y. (USA)). Nov 1976. Contract EY-76-C-02-0016. 37p. Dep. NTIS, PC A03/MF A01.

An assessment on a nonlinear structural analysis finite element program called NONSAP is given with respect to its inelastic analysis capability for pressure vessels and components. The assessment was made from the review of its theoretical basis and bench mark problem runs. It was found that NONSAP has only limited capability for inelastic analysis. However, the program was written flexible enough that it can be easily extended or modified to suit the user's need. Moreover, some of the numerical difficulties in using NONSAP are pointed out.

41466 (CONF-770301—12) **Testing of coatings for the nuclear industry.** Goldberg, G. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 5p. Dep. NTIS, PC A02/MF A01.

From 173. national meeting of the American Chemical Society; New Orleans, Louisiana, United States of America (USA) (20 Mar 1977).

Commercial scale nuclear power generating plant coatings must be able to withstand simultaneous exposure both to high humidity, and to cumulative radiation dosage, at elevated temperatures, for the design life of the plant. The coatings must be decontaminable by means other than by stripping, that is, actual physical removal, and must be of sufficient durability to withstand projected conditions of a loss of coolant accident. Tests to show that coatings are expected to do more than retard corrosion and erosion are described.

41467 (CONF-770401—9) **Direct-coupled-ray method for three-dimensional shielding analysis.** Bucholz, J.A. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 9p. Dep. NTIS, PC A02/MF A01.

From 5. international conference on reactor shielding; Knoxville, Tennessee, United States of America (USA) (18 Apr 1977).

A fast, three-dimensional design-oriented transport method has been developed for the solution of both neutron and gamma shielding problems. It combines a nodal approach with analytic integral transport to achieve relative speed and accuracy. An analytic solution is obtained for each of 14 angular fluxes in each mesh block of a three-dimensional assembly. The directions are such that the outgoing angular flux components in one mesh block become the incoming angular flux components in the adjacent mesh blocks. The approach is therefore described as the Direct-Coupled-Ray (DCR) method. The DCR method with full anisotropic scattering capability, variable mesh capability, and generalized boundary conditions, has been implemented in the TRANS3 code. Several benchmark calculations and numerous scoping calculations were performed using problems representative of LMFBR shielding configurations. These included a 1-D deep penetration configuration and one-, two-, and three-dimensional representations of the lower axial shield of the Clinch River Breeder Reactor (CRBR).

41468 (CONF-770401—13) **Spatial channel theory: A technique for determining the directional flow of radiation through reactor systems.** Williams, M.L.; Engle, W.W. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 8p. Dep. NTIS, PC A02/MF A01.

From 5. international conference on reactor shielding; Knoxville, Tennessee, United States of America (USA) (18 Apr 1977).

A method is introduced for determining streaming paths through a non-multiplying medium. The concepts of a "response continuum" and a pseudo-particle called a contribution are developed to describe the spatial channels through which response flows from a source to a detector. An example application of channel theory to complex shield analysis is cited.

41469 (IAEA-CN—36/306) **Trends in the development of reactor containments.** Turricchia, A. (International Atomic Energy Agency, Vienna (Austria)). 1977. 12p. (In French). (CONF-770505—160). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

4.1.-.T.3./06 8 figs.

The paper presents a review of the technical developments which the containment systems of BWRs, PWRs and HWRs have undergone in the USA, Europe and Canada. The great variety of existing containment systems have been classified for each type of reactor, according to: principle of operation (i.e. dry containment; pressure suppression containment; containment with vacuum building; sub-atmospheric containment; etc.); type and number of the physical barriers provided against the dispersion of fission products to the environment (single containment, double containment, single containment with local collection of the leaks from the most probable leakage paths, or with pressurization of the potential leakage paths, etc.); and structural characteristics of the containment barriers (reinforced concrete, prestressed concrete, metal containment, liners). In the framework of this classification the main features of the various containment systems are illustrated, with special emphasis on the most modern designs. The difference in trend among various countries and various designers are highlighted. A review is also made of the various containment auxiliary systems which would operate in accident conditions (isolation systems, heat removal system, atmosphere control system, etc.). Also for these systems the main design criteria are set forth and present trends are described. Finally, a brief survey is also made of the present trends with regards to the design of containment structures against external events be they of natural origin (earthquake, tornadoes, etc.) or connected with human activities (airplane crash, explosions, etc.).

41470 (INIS-mf—3389, pp 123-148) **Reproducibility problems of in-service ultrasonic testing results.** Honcu, E. (Statni Vyzkumny Ustav Materialu, Prague (Czechoslovakia)). 1974. (In Czech).

In In-service inspection and diagnostics of nuclear power installations. Part 1.

The reproducibility of the results of ultrasonic testing is the basic precondition for its successful application in in-service inspection of changes in the quality of components of nuclear power installations. The results of periodic ultrasonic inspections are not satisfactory from the point of view of reproducibility. Regardless, the ultrasonic pulse-type method is suitable for evaluating the quality of most components of nuclear installations and often the sole method which may be recommended for inspection with regard to its technical and economic aspects.

41471 (INIS-mf—3389, pp 52-55) **Element-type steam generators inspection with regard to operating reliability.** Kafka, F.; Jung, J.; Rybnicek, J. (Prvni Brnenska Strojirna, Zavody K. Gottwalda, Oborovy Podnik, Brno (Czechoslovakia)). 1974. (In Czech).

In In-service inspection and diagnostics of nuclear power installations. Part 1.

One of the main problems of most steam generators is maintaining tight joints between very thin tubes forming the heating surface and the massive tube plate. The possibilities are assessed of checking the tightness of these joints during production and in operation. The basic aspects are analyzed of evaluating residual life of the sections of steam generators and other pressure components: the condition of surface exposed to the effects of media, geometrical changes, changes of mechanical properties of construction materials, the state of welds and adjoining parts and the homogeneity of the material.

41472 (ORNL/Sub/4164—2) **ISA: Ineractive Stress Analysis. A program for plane stress, plane strain and axisymmetric analysis of structural continua. User's manual.** Abdulrahman, H.O. (Illinois Univ., Urbana (USA). Dept. of Civil Engineering). Jul 1976. Contract W-7405-ENG-26;SUB-4164. 35p. (UILU-ENG—76-2028). Dep. NTIS, PC A03/MF A01.

The program is applicable to linear problems and has been developed as the foundation of a nonlinear finite-element program for the analysis of two- and three-dimensional structures. It was developed as part of an investigation of prestressed concrete reactor vessels. Hence it is oriented towards the analysis of reinforced and prestressed concrete structures. The operational part of the program

can be used to obtain elastic stress and strain distributions in a two-dimensional continuum; namely plane stress, plane strain and axisymmetric stress conditions.

41473 Three-dimensional stress analyses of mitered elbows. Pan, Y.S.; Anderson, T.L.; Skopp, G.H. (North Am Rockwell Corp, Canoga Park, Calif). *Am. Soc. Mech. Eng., [Pap.];* No. 75-PVP-54, vp(1975).

Three-dimensional elastic stress analyses of a mitered elbow have been performed by the application of the MARC finite element program. Seven basic unit load cases have been considered. Results of these reference load cases may be applied in any combination to stress analyses of the same elbow subjected to more complicated loading conditions. According to results from these analyses, when a mitered bend is subjected to in-plane loads, it exhibits behavior similar to that of a smooth elbow under the same loading conditions. Results from out-of-plane load cases show some deviation from the behavior of a smooth bend. These discrepancies cast some doubts on the conventional method of stress analyses of a mitered bend. 16 refs.

41474 Thermal mechanical analysis procedure for a semicircular plate with clamped straight edge. Wu, J.N.C.; Hechmer, J.L. (Babcock and Wilcox Co, Akron, Ohio). *Am. Soc. Mech. Eng., [Pap.];* No. 75-PVP-55, vp(1975).

A U-tube steam generator utilizes a semicircular plate known as a divider plate to baffle the primary side inlet fluid from the outlet fluid. An analytical solution is given for a through thickness thermal gradient and a pressure loading. The plate is simply supported along the circumferential edge and clamped at its straight edge. The problem is solved by first analyzing a full circular plate with a thermal and/or pressure loading. Next a diametrical line load is applied perpendicular to the plate with the magnitude so adjusted that the deflection along the diameter is equal to zero. Numerical results are developed and an example problem is shown. The results of the example problem are correlated with results from a 3-D finite element analysis. 4 refs.

41475 Three-dimensional finite element analysis of a steam generator channel-head-complex: comparison of theory and experiment. Bertsch, O.L.; Sun, C.L.; Conway, L. (Westinghouse Electr Corp, Tampa, Fla). *Am. Soc. Mech. Eng., [Pap.];* No. 75-PVP-59, vp(1975).

The purpose of this investigation is to compare three-dimensional stress and displacement distributions determined analytically and experimentally. The geometry chosen was a steam generator channel-head-complex. The analytic procedure employed a three-dimensional elastic finite element approach, using linear, quadratic, cubic and mixed isoparametric hexahedral elements. The experimental procedure employed frozen stress photoelastic models. Three different types of loading: internal pressure, nozzle moment, and nozzle thrust were considered and calculated stresses and displacements at selected points were compared with results generated by a photoelastic analysis. The comparison showed generally close agreement between these two sets of results. 4 refs.

41476 Effects of the steam chest on steamhammer analysis for nuclear piping systems. Luk, C. (Stone and Webster Eng Corp, Boston, Mass). *Am. Soc. Mech. Eng., [Pap.];* No. 75-PVP-61, vp(1975).

When applying the method of characteristics for the steamhammer analysis of a nuclear piping system, if the dynamic fluid behavior in the steam chest is not considered, the boundary condition thus formulated to describe the time-dependent fluid behavior of the steam chest would lead to numerical unstable solution. To overcome this difficulty, the dynamic fluid behavior in the steam chest can be described by a single degree mechanical system. The corresponding flow conditions there are then determined by the time-step amplification method. This dynamic boundary condition reduces the calculated steamhammer loads and helps avoid numerical instability problems in the computing procedure. 4 refs.

41477 Interpretation of finite element stresses according to ASME Section III. Kroenke, W.C.; Addicott, G.W.; Hinton, B.M. (Babcock and Wilcox, Barberton, Ohio). *Am. Soc. Mech. Eng., [Pap.];* No. 75-PVP-63, vp(1975).

Stresses from finite element analyses of typical pressure vessel components are classified and compared against ASME Section III stress limits. Procedures are given for the location of critical planes in vessel components, the division of total stresses into membrane, bending, and peak categories, and the assignment of stresses to the primary, secondary, or peak categories. Emphasis is placed on the presentation of specific results for a nozzle and a bolted closure analysis. 2 refs.

41478 Dynamic load amplification factors for safety valve headers. Lee, M. (Gilbert Assoc, Inc, Reading, Pa). *Am. Soc. Mech. Eng., [Pap.];* No. 75-PVP-70, vp(1975).

The loads on a safety valve header induced by safety valve discharge reaction forces are dynamic in nature. A precise dynamic analysis of a safety valve station is costly and may not be practical. A simplified method of calculating the dynamic load amplification factors to be used in the stress analysis of the header under the safety valve discharge loading is presented. The effects of load-time amplification and the valve locations are considered so that dynamic stress can be obtained by employing static analysis. It is shown that an amplification factor smaller than two can be used conservatively in many safety valve installations. 10 refs.

41479 Water chemistry conditions of saturated steam turbines. Margulova, T.Kh.; Kosyak, Yu.F. (Moscow Power Eng Inst, USSR). *Teploenergetika (Moscow);* No. 6, 37-39(Jun 1975). (In Russian).

The problem of deposition of corrosion products, especially iron oxides, on the surface of flow-through sections of turbines operating on saturated steam, is considered with regard to the water regime of the reactors of single-loop nuclear power plants or steam generators of two-loop nuclear power plants. It is suggested that feedwater treatment with EDTA ammonium salt may be conducive to the dissolution of iron oxide slurry in water and thus prevent the formation of these deposits in the flow-through part of turbines. The importance of high drying of steam in the reactor is also stressed.

41480 Operational experience with heat exchangers in nuclear power stations with light water reactors. Baschek, H.; Kocourek, E. *Combustion;* **47**: No. 3, 14-23(Sep 1975).

In many light water nuclear power stations, defects were increasingly observed in heat exchangers which had badly affected the availability of the plant, although they did not impair the safety of the stations. The cause of the failures is in many cases the lack of a full understanding of the complex processes during evaporation and condensation of the water and the consequent mutual relationships between design, chemistry and material. Eddy current measurements periodically carried out contribute to keeping the existing problems under control.

41481 Experience focuses attention on details of in-service inspection in nuclear plants. Birkle, A.J. (Consumers Power Co, Jackson, Mich). *Power (N.Y.);* **119**: No. 9, 104-105(Sep 1975).

A checklist is presented for planning inspections under Section XI of the ASME Boiler Code which is related to the needs of operators and consultants.

41482 Cracking of reinforced concrete heated cylindric containers in the presence of thrusting slabs. Fontana, A. (Politec di Milano, Italy). *Energ. Elettr.;* **53**: No. 6, 322-332(Jun 1976). (In Italian).

The study of cracked condition in r.c. cylindrical container walls subjected to thermal gradients and in the presence of thrusting slabs is carried out by examining the behavior of both physical and mathematical models. The comparison of the results obtained leads to the conclusion that the study of cracked condition of the structure in question can be made by resorting to the calculation method set forth. Results are also discussed with reference to the regulations in force in the sector being studied. 23 refs.

41483 Development of the Super-Sipper in-core and out-of-core failed fuel detection systems. Wachter, W.J.; Lee, R.B. (Wachter Assoc, Inc, Pittsburgh, Pa). *Am. Soc. Mech. Eng., [Pap.];* No. 76-WA/NE-20, 1-7(5 Dec 1976).

Wachter Associates has completed preliminary proof of principle tests on the Super-Sipper Service. The simplest version of the unit will be used to fast sort fuel coming out of the reactor during refueling. The Super-Sipper test provides the nuclear utility industry with a practical, simple method for checking the nuclear fuel assembly, new and after each cycle. It filters out physical defects present during receiving and installation, thus insuring that no quality assurance statistician's 'bad element' gets to the reactor. In this regard, it serves as the final quality control check point on nuclear fuel. After each cycle the fuel assembly can be checked using the 'fast sort' mode of super-sipping. If an indication occurs on new fuel, the fuel assembly is rejected. If an indication occurs on the fuel assembly during an interim cycle, the failed rod is located using the tank Super-Sipper and the assembly is then rejected or reconstituted. The system is designed to provide information on fuel condition without interference with refueling operaions and, therefore, causes no delay in getting the reactor back on line.

41484 Simulation of spray canal cooling for power plants--performance and environmental effects. Arndt, C.R.; Barry, R.E. (Detroit Edison, Eng Res Dep, Mich). *Am. Soc. Mech. Eng., [Pap.];* No. 76-WA/HT-28, 1-5(5 Dec 1976).

A computer simulation is developed to predict the thermal performance and environmental effect of powered spray modules positioned in a canal to cool power plant condenser discharge water. The simulation takes into account the effects of air and water temperature, wind speed and direction, atmospheric stability and lapse rate, relative humidity, spray module configuration and other important variables. The model is capable of predicting local water and air temperatures and the production and concentration of downwind fog for up to five separate canals located on one side. The

underlying assumptions leading to the development of the model are fully explained and an example is presented showing its application. 10 refs.

41485 Comparison of the power distribution in uranium and plutonium fuel elements in the KWO core. Sommer, D. *Nucl. Technol.;* **32**: No. 3, 257-275(Mar 1977).

The introduction of plutonium-charged fuel elements was investigated with regard to a change in the axial power density distribution. An attempt was made to gather information regarding the influence of coolant temperature change on the local power production. The state of the reactor during the investigations was supposed to correspond to realistic operating conditions. During stretch-out operation, as a result of the reduction of the mean coolant temperature and the reactor power, the fall in coolant outlet temperature is greater than the rise in inlet temperature. Hence, the greatest coolant density change occurs at the coolant outlet. In this manner, the relative power density distribution is displaced toward the upper core half. In a special experiment, the influence of turbine load changes on the axial power density distribution in a noncontrolled reactor was investigated. A power reduction at the turbine causes a rise in the mean coolant temperature of the reactor. Owing to local coolant temperature differences, the power density was found to displace toward the upper core half in a noncontrolled reactor, this being more so the case for plutonium fuel elements. The investigations cited in this report and the good agreement between the theoretical predictions and the experiments permitted the recycling of the self-bred plutonium at KWO without restrictions on the operation of the reactor.

FUEL ELEMENTS

41486 (CEA-CONF—3663) **In-pile gamma scanning. Application to power and burnup measurement and to the study of fission product migration.** Maman, A.; Chenebault, P.; Hairion, J.P.; Michel, F. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Metallurgie). 15 Nov 1976. 46p. (In French). (CONF-761161—1). Dep. NTIS (US Sales Only), PC A03/MF A01.

From Seminar on in-situ use of gamma spectrometry for studying and monitoring the water-reactor spent fuels; Courbevoie, France (16 Nov 1976).

The NATHALIE code intended for processing the data from the in-pile γ-scanning measurements effected at Siloe and Melusine is discussed with the results obtained especially for spent fuel power and burnup determination, and when the migration of a great number of fission products is to be investigated (CREATION code). In such a way, examples from some 150 scannings completed (12000 spectra) at Grenoble these last three years using some thirty irradiation devices are presented.

41487 (IAEA-CN—36/203) **Performance evaluation of UO_2-Zr fuel in power ramp tests.** Knudsen, P.; Bagger, C.; Kjaer-Pedersen, N. (International Atomic Energy Agency, Vienna (Austria)). 1977. 6p. (CONF-770505—139). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.4.-.T.2./05 3 tables, 8 figs.

In power reactors using UO_2-Zr fuel, rapid power increases may lead to failures in fuel pins that have been irradiated at steady or decreasing heat loads. The paper presents results which extend the experience with power ramp performance of high burn-up fuel pins. A test fuel element containing both pellet and vipac UO_2-Zr fuel pins was irradiated in the HBWR at Halden for effectively 2 1/2 years to an average burn-up of 21,000 MWD/te UO_2 at gradually decreasing power levels. The subsequent non-destructive characterization revealed formation of transverse cracks in the vipac fuel columns. After the HBWR irradiation, five of the fuel pins were power ramp tested individually in the DR 3 Reactor at Riso. The ramp rates in this test series were in the range 3-60 W/cm min. The maximum local heat loads seen in the ramp tests were 20-120% above the highest levels experienced at the same axial positions during the HBWR irradiation. Three pellets and one vipac fuel pin failed, whereas another vipac pin gave no indication of clad penetration. Profilometry after the ramp testing indicated the formation of small ridges for both types of fuel pins. For vipac fuel, the ridges were less regularly distributed along the pin length than for pellet fuel. Neutron radiography revealed the formation of additional transverse and longitudinal fuel cracks during the power ramps for both types of fuel pins. The observed failures seemed to be marginal since little or no indication as to the locations of the clad penetrations could be derived from the non-destructive post-irradiation examinations. The cases have been analyzed by means of the Danish fuel performance codes. The calculations, which are in general agreement with the observations, are discussed. The results of the investigations indicate qualitative similarities in over power performance of the two fuel types.

41488 (IAEA-CN—36/495) **Evaluation of in-reactor measurements of fuel rod deformations.** Firing, J.A.; Kolstad, E. (International Atomic Energy Agency, Vienna (Austria)). 1977. 5p. (CONF-770505—136). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.4.-.T.2./03 10 figs.

The paper reviews applications of precision measurement techniques for determination of fuel rod deformations under steady state and transient power conditions. Effects of design parameters such as gap size and pellet geometry are more pronounced early in life and have been extensively studied. Efforts have also been made to define the importance of design parameters in contributing to the axial deformation of the cladding during late-in-life power cycling. Strain relaxation reduces mechanical interaction between pellet and cladding, thus knowledge of the magnitude and time dependency of this phenomenon can contribute to the optimization of power changes. Axial cracks appear often on failed fuel rods. These axial cracks typically originate at the ridges formed at pellet interfaces. Whether the final failure results from pure mechanical overstraining and/or from stress corrosion processes is not satisfactorily understood, but a reduction of the general stress level is advantageous for reducing the failure causing effects in both processes. By measurements of fuel rod diameter changes at different operating conditions, local strains over entire rod lengths were determined. Such data can be used for verification of codes which predict the fuel rod performance. The paper presents examples of the verification of a finite element code against experimental data obtained from Halden fuel test rigs.

41489 (IAEA-CN—36/553) **Status of the development of mixed oxide fuels in PNC.** Muto, T.; Koizumi, M.; Naruki, K.; Itaki, T.; Amanuma, T. (International Atomic Energy Agency, Vienna (Austria)). 1977. 9p. (CONF-770505—142). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.5.-.T.1./02 2 tables, 4 figs.

PNC has been developing mixed oxide fuels for both thermal and fast reactors, since the startup of Plutonium Fuel Development Facility (PFDF) in November, 1965. The second facility called Plutonium Fuel Fabrication Facility (PFFF) was built in 1971 for the fabrication of plutonium fuels for both FBR and HWR project in PNC. The amount of Pu fuels fabricated in both facilities was over 16,000 fuel rods with 20 tons of mixed oxide pellets at the end of 1976 for JOYO and other fuels, and is further increasing for FUGEN. Technical development work related to the fuel fabrication is mainly concentrated to the automation of process control and equipment together with the establishment of process for the FBR fuel pellet with low density and low O/M ratio. Quality assurance system has been arranged in accordance with increase of the fuel produced, and a fully documented system was completed for the FUGEN Pu fuel. Research and development work for Pu fuels performance has been focused on physical and chemical properties of mixed oxide, and in and out of pile evaluation of the fuel performance together with some activities related to Pu fuel design, and these results have been compiled in computer codes including fuel rod performance codes, PIPER and ACTIVE-II. Irradiation testings of the mixed oxide fuels totaling 418 rods were carried out successfully in JRR-2, JMTR, HBWR, SAXTON, GETR, Rapsodie and Dounreay. Besides, 3,624 fuel rods were fabricated and used for critical experiments in DCA, TCA, etc.

CONTROL SYSTEMS

REFER ALSO TO CITATION(S) 41349, 41437, 42335

41490 Reactor power control by a dual 305 computer system at Stade nuclear power station. Bock, H.W.; Profos, D.; Thoene, R. (Kraftwerk Union, Erlangen, Ger). *Siemens Rev.;* **43**: No. 7, 303-308(Jul 1976).

To prove the reliability of the process computer system at Stade Nuclear Power Station, an experimental program has been carried out in which most of the functions of the reactor power control were taken over by a dual process computer system. This program, which started in January 1974 and finished in May 1974, produced good results. A description is given of the control program and the program-related properties of the power control system.

41491 Magnetic jack control rod drives. Sherwood, D.G. (Westinghouse Electr Corp, Pittsburgh, Pa). *Am. Soc. Mech. Eng., [Pap.];* No. 76-WA/NE-3, 1-8(5 Dec 1976).

Magnetic jack actuators are linear stepping mechanisms which were developed to operate control rods in pressurized water reactors. The advantages of this type of actuator (long life in corrosive environment, load transfer, hermetic sealing) are described and other possible uses are given.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 41313, 42002, 42014

41492 (BNWL—2153) **Evaluation of nuclear power plant environmental impact prediction, based on monitoring programs. Summary and recommendations.** Gore, K.L.; Thomas, J.M.; Kannberg, L.D.; Watson, D.G. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Feb 1977. Contract EY-76-C-06-1830. 39p. Dep. NTIS, PC A03/MF A01.

An evaluation of the effectivenss of non-radiological environmental monitoring programs is presented. The monitoring programs for Monticello, Haddam Neck, and Millstone Nuclear Generating Plants are discussed. Recommendations for improvements in monitoring programs are presented.

41493 (IAEA-CN—36/588) **Energy policy and public acceptance.** Alfven, H. (International Atomic Energy Agency, Vienna (Austria)). 1977. vp. (CONF-770505—238). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

5.0.-.P.1./02 Published in summary form only.

41494 (ORNL/NUREG/TM—71) **Critical evaluation of the nonradiological environmental technical specifications. Volume 3. Peach Bottom Atomic Power Station Units 2 and 3.** Adams, S.M.; Cunningham, P.A.; Gray, D.D.; Kumar, K.D.; Witten, A.J. (Oak Ridge National Lab., Tenn. (USA)). 10 Aug 1976. Contract W-7405-ENG-26;NRC-INA-40-550-75. 185p. Dep. NTIS, PC A09/MF A01.

A comprehensive study of the data collected as part of the environmental Technical Specifications program for Units 2 and 3 of the Peach Bottom Nuclear Power Plant was conducted for the Office of Regulatory Research of the U.S. Nuclear Regulatory Commission. The program included an analysis of both the hydrothermal and ecological monitoring data collected from 1967 through 1976. Specific recommendations are made for improving both the present hydrothermal and ecological monitoring programs. Hydrothermal monitoring would be improved by more complete reporting of in-plant operating parameters. In addition, the present boat surveys could be discontinued, and monitoring efforts could be directed toward expanding the present thermograph network. Ecological monitoring programs were judged to be of high quality because standardized collection techniques, consistent reporting formats, and statistical analyses were performed on all of the data and were presented in an annual report. Sampling for all trophic groups was adequate for the purposes of assessing power plant induced perturbations. Considering the extensive period of preoperational data (six years) and operational data (three years) available for analysis, consideration could be given to reducing monitoring effort after data have been collected for a period when both units are operating at full capacity. In this way, an assessment of the potential ecological impact of the Peach Bottom facility can be made under conditions of maximum plant induced perturbations.

SITING

41495 (ORNL/CSD/TM—19) **PREPR2: a program to aid in the preparation of input data for the farout hydraulic transport code.** Holdeman, J.T. Jr. (Oak Ridge National Lab., Tenn. (USA)). May 1977. Contract W-7405-ENG-26;NRC-60190501, B0166-6. 89p. Dep. NTIS, PC A05/MF A01.

A computer code PREPR2 was written to aid in the preparation of data sets for the FAROUT/FAR2D/FARTMP/FARCCH/FARCRD computer codes used for the assessment of enviornmental impacts in power plant sitings. These latter hydraulic transport codes use two types of discrete elements, a rectangular internal element and a more complicated boundary element which incorporates the irregular shape of the region being simulated. The data set is prepared from a map of the area to be simulated and a description of the discrete element structure to be used. The computer program, the requirements for its use, and its use at an actual plant site are described.

41496 (ORNL/NUREG/TM—79) **Maryland Power Plant Siting Project: an application of the ORNL-Land Use Screening Procedure.** Dobson, J.E. (Oak Ridge National Lab., Tenn. (USA)). 1975. Contract W-7405-ENG-26;NRC-INA-40-543-75. 106p. Dep. NTIS, PC A06/MF A01.

Since 1974 the Resource Analysis Group in the Regional and Urban Studies Section of the Oak Ridge National Laboratory (ORNL) has been engaged in developing a procedure for regional and local siting analysis known as the ORNL Land Use Screening Procedure (LUSP). This document is the final report of the Maryland Power Plant Siting Project (MPPSP) in which the ORNL LUSP was used to identify candidate areas for power plant sites in northern Maryland. Numerous candidate areas are identified on the basis of four different siting objectives: the minimization of adverse ecologic impact, the minimization of adverse socioeconomic impact, the minimization of construction and operating costs, and a composite of all siting objectives. Siting criteria have been defined for each of these objectives through group processing techniques administered to four different groups of siting specialists. The siting priorities and opinions of each group have been expressed quantitatively and applied to a geographic information system containing 52 variables for each 91.8-acre cell in the northern eight counties of Maryland.

RADIOACTIVE EFFLUENTS

REFER ALSO TO CITATION(S) 41132

41497 (IAEA-CN—36/238) **Tritium formation and elimination in light-water electronuclear plants.** Dolle, L.; Bernard, C.; Bazin, J.; Miquel, P.; Briec, M. (International Atomic Energy Agency, Vienna (Austria)). 1977. 9p. (In French). (CONF-770505—165). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.2.-.T.2./10 4 figs.

In light-water reactors, the tritium balance should be considered from both the working constraint and environmental pollution aspects. In light-water electronuclear stations with pressurized reactors using boric acid in solution for reactivity control, the amounts of tritium formed in the primary circuit are worthy of note. The estimations concerning the tritium production in a hypothetical 1000 MWe reactor are discussed. In the tritium build-up, the part which takes the tritium formed by fission in the fuel, owing to diffusion through cladding, is still difficult to estimate. The tritium balance in different working nuclear power stations are consequently of interest. But the tritium produced by ternary fission in the fuel is always much more abundant, and remains almost entirely confined in the uranium oxide if the fuel is clad with zircaloy. The annual quantity stored in the fuel elements is more than 20 times larger than that of the built up free tritium in the primary circuit water of a reactor. It reaches about 12,400 Ci in the hypothetical reactor. In the presently operated reprocessing plants, tritium is all going over in the effluents, and is almost entirely released in the environment. Taking into account the increasing quantities of high irradiated fuel to be reprocessed, it seems necessary to develop separation processes. Development work and tests have been achieved jointly by CEA and SAINT-GOBAIN TECHNIQUES NOUVELLES in order to: contain the tritium in the high activity part of the plant; and keep small the tritiated effluent volume, about 300 liters per ton of reprocessed uranium. It is then possible to envisage a storage for decay of isotopic separation processes. Such separation processes have been estimated by CEA assuming a daily output of 1500 liters of water containing 2,3 $Ci.l^{-1}$ of tritium, the desired decontamination factor being 100.

CHEMICAL AND THERMAL EFFLUENTS

41498 **Stratified flows produced upon discharge of hot power-plant effluents into cooling ponds and rivers.** Makarov, I.I. *Fluid Mech. - Sov. Res.;* **4**: No. 1, 29-42(1975).

Problems of formation of stratified flows in stationary and moving waters, into which large quantities of hot effluent are discharged from fossil-fuel and nuclear power plants, are described. The resulting hydraulic phenomena are classified and control of the stratified flows is discussed. Results of model studies of stratified flows in streams, when the effluent forms a wedge upstream of the point of discharge, are presented.

41499 **Environmental impact assessment of cooling towers.** Bartlit, J.R.; Williams, M.D. (Sierra Club Natl Water Resour Comm, Los Alamos, NM). *Mater. Performance;* **14**: No. 9, 39-41(Sep 1975).

Downstream and downwind environmental impact of cooling water towers is reported and evaluated. Salt and chemical concentrations affecting downstream ecology in the atmosphere and in fresh and salt water are calculated, and specific examples of large-scale effects are given. Drift losses from towers and the extent and severity of the concurrent effect of chemicals are discussed, including the effects of chromium and zinc. Tower configuration, control measures, and climatic factors influencing mist distribution are explored and reported.

RESEARCH, TEST, AND EXPERIMENTAL REACTORS

REFER ALSO TO CITATION(S) 41405, 42335

41500 (HEDL-TC—812) **Pressure drop measurements in FFTF fuel vibration tests.** Thorne, W.L. (Hanford Engineering Develop-

ment Lab., Richland, Wash. (USA)). Apr 1977. Contract EY-76-C-14-2170. 17p. AT.

The results are reported of pressure drop flow measurements taken as part of the program to ascertain the vibration modes of a 217 pin, FFTF fuel subassembly. The hydraulics measurements were made for the following purposes: (1) measure the hydraulic characteristics of the upper support grid, and (2) provide early design data on the hydraulic characteristics of the neutron shield-orifice plate and flow distribution plate assembly.

41501 (HEDL-TI—76034-6) **Interim stress analysis report of liquid metal pipe clamp assemblies for Fast Flux Test Facility.** (Hanford Engineering Development Lab., Richland, Wash. (USA)). Aug 1975. Contract EY-76-C-14-2170. 135p. AT.

Structural analyses are being performed on the Fast Flux Test Facility pipe clamp supports as identified in ordering data HWS-1102. This is an interim report of the evaluation. The report identifies and describes the analyses which have been performed; presents the results and conclusions of these analyses, including the results of materials testing which was performed in support of the analytical effort; identifies additional analyses which are required and will be performed; and identifies additional materials test data which are required to complete the evaluation.

41502 (IRI—131-76-01) **Hybrid computer simulation of the dynamics of the Hoger Onderwijs Reactor.** Moers, J.C.; de Vries, J.W. (Interuniversitair Reactor Instituut, Delft (Netherlands)). 1976. 99p. (In Dutch). Dep. NTIS (US Sales Only), PC A05/MF A01.

24 refs., 17 figs., 8 apps.

A distributed parameter model for the dynamics of the Hoger Onderwijs Reactor (HOR) at Delft is presented. The neutronic and the thermodynamic part of this model have been separately implemented on the AD4-IBM1800 Hybrid Computer of the Delft University of Technology Computation Centre. A continuous Space/Discrete Time solution method has been employed. Some test results of the simulation are included.

41503 (ORNL/MIT—232) **Steady state heat transfer in ORR irradiation capsules. Part 2.** Michel, R.C.; Michaels, S.L.; Wilkes, G.R. (Oak Ridge National Lab., Tenn. (USA)). 26 Apr 1976. Contract W-7405-ENG-26. 101p. Dep. NTIS, PC A06/MF A01.

The mathematical model developed by Stiros for prediction of temperature profiles in ORR irradiation capsules was modified and a numerical solution obtained. A Fortran computer program was written to solve the generalized finite difference equations applied to a fixed lattice system superimposed on the capsule cross section. The Liebmann iterative method was employed. The solution accounts for changes in internal heat generation, thermal expansion, and thermal conductivity induced by both temperature and fluence. The computed temperatures deviated from actual experimental measurements in the fuel rods by less than 2.0 percent.

41504 (WARD—2171-64) **Fast Flux Test Facility. Final report on FFTF outlet plenum buoyancy effects study.** Carr, J.A.; Flanigan, L.J. (Battelle Columbus Labs., Ohio (USA)). 21 Mar 1975. Contract E(45-1)-2171. vp. AT.

To insure that the proposed design of the FFTF outlet plenum and piping was adequate, Westinghouse ARD concluded that a quantitative evaluation of the effects of fluid density and flow rate changes during a reactor scram was necessary. Battelle's Columbus Laboratories was selected by ARD to conduct this quantitative flow evaluation. The results are presented of the flow modeling studies conducted by Battelle to obtain quantitative mixing data for evaluating the effect of fluid and flow rate change on the mixing characteristics of the FFTF outlet plenum during a normal scram.

41505 **Fluidelastic tube vibration in a heat exchanger designed for sodium-to-air operation.** Halle, H.; Boers, B.L.; Wambsganss, M.W. (Argonne Natl Lab, Ill). *Am. Soc. Mech. Eng., [Pap.]*; No. 75-Pwr-B, vp(1975).

Analysis and testing were performed to evaluate the potential for flow induced vibrations of the finned U-tubes of a sodium-to-air dump heat exchanger of the Fast Flux Test Facility (FFTF). The analysis showed that fluidelastic vibration of the U-bend sections, caused by a displacement-dependent mechanism, could be experienced. Consequently, model tests, with prototypic tubing and stagnant water simulating the sodium mass on the tubeside, were performed. The tests consisted of subjecting the overhanging U-bends of a bank of five U-tubes to a range of air flow velocities at room temperature. Test results showed that, for a given support and restraint condition, a critical flow velocity exists above which large vibration amplitudes are induced. Characterization of the critical flow velocity was investigated. Supplementary single tube experiments determined vortex shedding frequencies, U-tube natural frequencies, damping, and, separately, the effect of internal water flow. 4 refs.

PLUTONIUM AND ISOTOPE PRODUCTION REACTORS

41506 (UNI—187(Rev.1)) **Braze ring qualification program.** Gant, R.G.; Zilar, J.A. (United Nuclear Industries, Inc., Richland, Wash. (USA)). 1 Mar 1977. Contract EY-76-C-06-1857. 5p. Dep. NTIS, PC A02/MF A01.

Requirements for the formal qualification of a vendor for the fabrication of braze rings are defined.

PROPULSION REACTORS

REFER ALSO TO CITATION(S) 41662

41507 (IAEA-CN—36/93) **Nuclear merchant ship propulsion.** Schroeder, E.; Jager, W.; Schafstall, H.G. (International Atomic Energy Agency, Vienna (Austria)). 1977. 6p. (CONF-770505—175). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

8.0-.T.1./12.

The operation of about 300 nuclear naval vessels has proven the feasibility of nuclear ship propulsion. Until now six non military ships have been built or are under construction. In the Soviet Union two nuclear icebreakers are in operation, and a third one is under construction. In the western world three prototype merchant ships have been built. Of these ships only the NS OTTO HAHN is in operation and provides valuable experience for future large scale use of nuclear merchant ship propulsion. In many countries studies and plans are made for future nuclear merchant ships. Types of vessels investigated are large containerships, tankers and specialized ships like icebreakers or ice-breaking ships. The future of nuclear merchant ship propulsion depends on three interrelated items: (1) nuclear ship technology; (2) economy of nuclear ship propulsion; (3) legal questions. Nuclear merchant ship technology is based until now on standard ship technology and light water reactor technology. Except for special questions due to the nonstationary type of the plant entirely new problems do not arise. This has been proven by the recent conceptual licensing procedure for a large nuclear container ship in Germany. The economics of nuclear propulsion will be under discussion until they are proven by the operation of privately owned lead ships. Unsolved legal questions e.g. in connection with port entry permissions are at present another problem for nuclear shipping. Efforts are made to solve these questions on an international basis. The future development of nuclear energy electricity production in large land based plants will stimulate the employment of smaller units. Any future development of long distance sea transport will have to take this opportunity of a reliable and economic energy supply into account.

41508 (PB—254750) **Ship collision study. Present situation survey. Final report, Jul 1974—Oct 1975.** Minorsky, V.U. (Sharp (George G.), Inc., New York (USA); Babcock and Wilcox Co., Lynchburg, Va. (USA)). 21 Nov 1975. 88p. NTIS, PC A05/MF A01.

Sponsored in part by Babcock and Wilcox Co., Lynchburg, Va.

Collision research since the Savannah is briefly reviewed. A bibliography of 74 papers is given in four categories: Research, statistics and probabilities, avoidance, and miscellaneous. Of these, 14 were translated and 34 abstracted. The abstracts are included in the report.

REACTOR SAFETY

41509 (BNL-NUREG—50602(Pt.1)) **Preaccident modeling of an LMFBR plant for SSC-L.** Agrawal, A.K. (Brookhaven National Lab., Upton, N.Y. (USA)). Dec 1976. Contract EY-76-C-02-0016. 155p. Dep. NTIS, PC A08/MF A01.

Physical models for various processes in preaccident or steady-state calculations for the entire liquid metal fast breeder reactor plant are described in this report. A computer program for this initialization phase was written to serve as the starting point for the transient version of the SSC-L code. All of the models and programming are applicable to the "loop" type plants.

41510 (GA-A—14079) **Gas-cooled fast breeder reactor accident initiation and progression analysis. Progress report, July 1, 1975—June 30, 1976.** Kelley, A.P. Jr. (General Atomic Co., San Diego, Calif. (USA)). Mar 1977. Contract EY-76-C-03-0167-023. vp. Dep. NTIS, PC A09/MF A01.

A program of safety studies for the gas-cooled fast breeder reactor (GCFR) is being performed. This program involves analyses of the progression of very-low-probability sequences of events

which would lead to loss of in-place coolable core geometry (core disruptive accidents) and their consequences. These studies are being performed at General Atomic (GA) and Argonne National Laboratory (ANL); corresponding analyses of accident probabilities are being carried out at GA. This report presents a summary of the work performed at GA on the probabilistic analysis of accident sequences which have the potential for initiating a loss of in-place coolable core geometry.

41511 (GEAP—21304-3) **BWR blowdown/emergency core cooling third quarterly progress report, July 1—September 30, 1976.** Burnette, G.W. (General Electric Co., San Jose, Calif. (USA). Boiling Water Reactor Systems Dept.). Oct 1976. 18p. Dep. NTIS, PC A02/MF A01.

Completion of the 8 x 8 test plan, qualification of the countercurrent flow-limiting (CCFL) restriction sizing technique, subcooled CCFL performance testing and design of many TLTA modifications and emergency core cooling ECC system components highlight the work completed.

41512 (IAEA-CN—36/18) **Safety considerations in fast reactor fuel development.** Roake, W.E.; Hanson, J.E.; Simpson, D.E.; Cunningham, G.W.; Avery, R.; Stratton, W.R. (International Atomic Energy Agency, Vienna (Austria)). 1977. 7p. (CONF-770505—200). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

4.2.-.T.1./03 3 tables.

The role that core-disruptive accidents play in the overall safety evaluation of fast reactors has not always been well defined or universally agreed upon. They have, however, become a traditional consideration in LMFBR safety. Reactors are carefully designed to minimize the potential for serious malfunctions and to incorporate automatic protective features which will terminate the effects of identifiable malfunctions within defined acceptable limits. The approach that is being followed in the United States is to also provide consequence-limiting features which will protect the public against the effects of an excursion beyond the capacity of the normal protective systems. These have been previously described as the four lines of assurance: prevention of accidents, limitation of core damage, containment of accidents in primary system and attenuation of radiological products. Typically, the response and adequacy of these consequence-limiting features are determined by evaluating the response of parts of the reactor system to a spectrum of simulated core-disruptive accidents. Similar considerations are applied to other parts of the fuel cycle. Theoretical and experimental studies of potential initiators for core disruption and the subsequent reactor bahaviour are discussed. The methods used to analyze and predict the course of core-disruptive accidents from initiating events to complete core disruption, and its effect on reactor structures are described, as are the experimental bases for the analyses. Specific developments in the technology and experimentation that support these analyses are discussed, including extensive experimentation in TREAT with fresh and preirradiated fuel pins prototypic of FFTF and CRBR.

41513 (IAEA-CN—36/36) **Gas-cooled fast reactor safety.** Rickard, C.L.; Simon, R.H.; Buttemer, D.R. (International Atomic Energy Agency, Vienna (Austria)). 1977. 11p. (CONF-770505—199). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

4.2.-.T.1./09.

Initial conceptual design work on the GCFR began in the USA in the early 1960s and since the later 1960s has proceeded with considerable international cooperation. A 300 MWe GCFR demonstration plant employing three main cooling loops is currently being developed at General Atomic. A major preapplication licensing review of this demonstration plant was initiated in 1971 leading in 1974 to publication of a Safety Evaluation Report by the USAEC Directorate of Licensing. The preapplication review is continuing by addressing areas of concern identified in this report such that a major part of the work necessary to support the actual licensing of a GCFR demonstration plant has been established. The safety performance of the GCFR demonstration plant is based upon its inherent safety characteristics among which are the single phase and chemically inert coolant which is not activated and has a low reactivity worth, the negative core power and temperature reactivity coefficients and the small and negative steam reactivity worth. Recent studies of larger core designs indicate that as the reactor size increases central fuel, clad and coolant reactivity worths decrease and the Doppler coefficient becomes more negative. These inherent safety characteristics are complemented by safety design features such as enclosing the entire primary coolant system within a prestressed concrete pressure vessel (PCRV), providing two independent and diverse shutdown systems and residual heat removal (RHR) systems, limiting the worth of control rods to less than $1, employing pressure-equalized fuel rods, a core supported rigidly at its upper end and otherwise unrestrained and coolant downflow within the core to enhance debris removal should local melting occur.

41514 (IAEA-CN—36/73) **SGHWR safety design and evaluation.** Smith, D.R.; Merrett, D.J.; Ward, D.A. (International Atomic Energy Agency, Vienna (Austria)). 1977. 9p. Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 - 13 May 1977).

4.1.-.T.2./10 1 fig.

The paper discusses the characteristic features of the S.G.H.W.R. and identifies the single channel concept as of considerable importance. The unique feature of the design is the provision of individual spray cooling E.C.C.S. to each channel. This spray cooling occupies a prominent position in the main line safety arguments. The reliance on this form of spray cooling leads to provision of a comprehensive E.C.C.S. system of high reliability. Duplicate systems with diverse power and water sources cover the complete pressure range to give very high confidence that spray cooling is available in all major L.O.C.A.s. On the other hand hydraulic analysis of the blowdown phase demonstrates that significant convective flow is available as an alternative/supplementary cooling regime for most faults. The reactor shutdown mechanisms have also been duplicated and will be designed to high reliabilities to give surety of reactor trip in all credible faults. The comparative performance of the two systems is considered. Extent of diversity and redundancy in trip parameters is also discussed. A feature of channel concept is that the pipe sizes can be made relatively small thus restricting rates of blowdown, and the paper discusses effects of this upon long term cooling and flooding arguments. The quantities of pipework in the primary circuit introduce considerations of integrity and the paper goes on to list the measures introduced to improve segregation and protection of individual sections of the plant so that the extent of possible L.O.C.A.s is minimised. The achievement of high standards of reliability by use of in-service inspection is covered, with particular reference to the steam drums. The impact of these inspection requirements upon the very low man-rem exposures required by U.K. utilities is also included.

41515 (IAEA-CN—36/127) **Analysis of loss of coolant accidents.** Birkhofer, A.; Kellermann, O.; Smidt, D. (International Atomic Energy Agency, Vienna (Austria)). 1977. vp. (CONF-770505—152). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

4.1.-.T.3./05 This entry prepared from abstract.

In the FRG, the effectiveness and the reliability of the systems which are necessary to control loss of coolant accidents are judged mainly by criteria given in the guidelines of the RSK for PWR and BWR. Although the guidelines concerning the effectiveness are derived from the USNRC ECCS Acceptance Criteria, conceptual differences between American and German plants require specific considerations of several points. Two examples for conceptual differences are the simultaneous injection of the ECCS into the hot and cold legs for the PWR and the internal recirculation pumps for the BWR. For years, computer models used for the analysis of loss of coolant accidents have been developed and improved intensively by vendors and experts responsible for the safety review. The present status of the calculating methods for the different phases of loss of coolant accidents are given. The interrelations with experiments in the reactor safety research program of the Federal Government are also shown. The importance of reliability analysis techniques for judging the engineered safeguards are discussed. In the licensing procedures, these methods are being increasingly used in addition to techniques based on failure assumptions as given by the RSK-guidelines (e.g. single failures, components under repair).

41516 (IAEA-CN—36/132) **Design of KWU LWR safety systems.** von Haebler, D. (International Atomic Energy Agency, Vienna (Austria)). 1977. 14p. (CONF-770505—). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

4.1.-.T.2./06 5 figs.

In the 10 years of development which lie between the design of the 300 MWe Obrigheim plant and the KWU Standard 1300 MWe PWR of today, the engineered safeguards were extended to cope with an enlarged variety of anticipated accidents. The KWU Safety System meets these demands with proven principles of the protection system, of software and hardware: protective functions which must be actuated within half an hour are automated and are independent from normal control, so that no action of the operator is necessary except to implement long-term protective procedures. Two random failures must not jeopardize reactor power trip capability nor shall a spurious failure trip the reactor or lead to more than one safeguard actuation if such action is not clearly oriented towards safety. Redundant sub-systems are installed in separate rooms in the reactor building and the control room building. In order to be protected from external events, such as a plane crash or gas explosion, parts of the electrical and mechanical equipment, including an

emergency control room, are protected by reinforced concrete buildings. The core is protected against flux tilts by quick responding and accurate in-core instrumentation which, coupled with a local power distribution control system, reduced integral reactor power prior to reaching intolerable Fsub(q) values. Many years of operational experience with power reactors and an efficient quality control system have led to highly reliable mechanical and electrical safety equipment, which assures highly satisfactory values of safety and availability for all KWU nuclear power plants.

41517 (IAEA-CN—36/159) **Status for seismic design requirements of nuclear power plants in Japan.** Takahashi, H. (International Atomic Energy Agency, Vienna (Austria)). 1977. 10p. (CONF-770505—150) Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

4.1.-.T.3./09 3 figs.

The fundamental purpose for the aseismic design of the nuclear power plants is to protect the inhabitants near the plant from radiation accidents during and after earthquake vibrations. In order to achieve the above purpose, the following considerations have been made. All buidlings, structures, system and components are classified into three Classes A, B and C according to their degree of importance for plant safety, and are designed to meet the requirements specified for each class, respectively. Magnitude and epicenter of the design basis earthquake are determined based upon seismological and geological investigations and observation of ground motion in the site, and the maximum ground acceleration which could be expected can be calculated empirically. With respect to time history waves, more than three are selected referring to dynamic characteristic of base rock in the site, observed ground motion records in the site or other strong motion seismographs.The figures of horizontal seismic coefficients to be used in determining design forces on Class A buildings and structures are 3 Co (where Co. is as defined in the Japan Building Standard Law). On the other hand the horizontal design force should not be less than those determined as the results of the dynamic analyses based on DEGM (Design Earthquake Ground Motion). The figures of horizontal seismic coefficient and forces for Class A system and components are usually determined based on the dynamic analyses for DEGM. The buildings and structures treated as an elastic column system with masses, and the bottom mass is supported by elastic springs representing the soil-foundation interaction characteristics. DEGM is used as the input disturbance in the dynamic response analysis, and the model analysis or time history method is worked out. System and components are modeled as elastic bars with lumped masses of 3 dimensional degree of freedom, and the response analysis is carried out using floor respone spectra.

41518 (IAEA-CN—36/181) **Safety of heavy-water reactors.** Pease, L.; Shell, V.G. (International Atomic Energy Agency, Vienna (Austria)). 1977. 7p. (CONF-770505—180). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

4.1.-.T.2./08 3 figs. Also available in French.

The functional requirements of reactor process, protective, and containment systems for CANDU pressurized heavy-water reactors (PHWR) are similar to those for other water-cooled reactors. Integrity of the primary-coolant boundary is required for safety reasons but, in practice, economic considerations impose more restrictive parameters. Canadian experience with several thousand tube-years of operation confirms the design criteria and establishes that basic safety and reliability requirements are achieved. The natural-uranium fuel cycle requires on-load fuelling, and for this reason the reactivity-holddown requirements are small. The control devices are not within the pressure boundary and are not subject to ejection by coolant pressure. The positive void effect is the only pressure-assisted reactivity effect possible in the PHWR. Although it is not self-evident, this does not impose on the reactor shutdown system, reliability requirements that are more severe than for any other reactor. A low-pressure emergency-injection system is sufficient to give a cooling effectiveness appropriate to the circumstances which invoke it. Thus for small breaks the emergency core cooling (ECC) serves as a back-up to the primary heat-transport make-up system. For large breaks, the ECC system provides enough flow to flood the core, ragardless of break location. A loss-of-coolant accident may damage the fuel to an extent which is a funciton of break size and location. There is no damage to the primary heat-transport system boundary beyond, of course, the damage which initiated the hypothesized event.

41519 (IAEA-CN—36/245) **European in-pile investigations on fast breeder reactor safety.** Bailly, J.; Kessler, G.; Penet, F.; Teague, H.J. (International Atomic Energy Agency, Vienna (Austria)). 1977. 11p. (In French). (CONF-770505—185). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

4.2.-.T.1./08 2 tables.

Because of the difficulties faced by the various organisations responsible for the design and safety analysis of fast reactors, in the conception and execution of perfectly representative experiments corresponding to the various hypothetical accidents considered, the European experts in this field have chosen to adopt a more fundamental approach. By the coordination of the efforts in the different countries and pooling the results, it appears that sufficient data can be assembled to permit them to: isolate the influence of the principle parameters on the course of an accident and to have an appreciation of the possibilities for detection and propagation; and validate calculational models of the essential phenomena, and determine the values of the adjustable parameters used in accident codes. Particular consideration is given to local blockages (SCARABEE, DFR and MOL 7C programmes), unprotected loss of pumps leading to cooling failure, and inlet blockage (SCARABEE and CABRI), and reactivity excursions (CABRI and VIPER). In addition it is planned to study, as part of the SCARABEE programme, the long-term post-accident behaviour of fuel in some simple configurations. It is shown that these various results should lead to a great improvement in our understanding of the progress of the hypothetical accidents taken into account in the design of fast breeder reactors.

41520 (IAEA-CN—36/279) **Experimental investigations of the power ramp failure propensity of LWR fuel.** Mogard, H.; Bergenlid, U.; Bodh, R.; Lysell, G. (International Atomic Energy Agency, Vienna (Austria)). 1977. 10p. (CONF-770505—141). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

2.4.-.T.2./04 6 figs.

The report reviews experimental investigations, performed at Studsvik, Sweden, of the failure propensity of LWR fuel under power upramp conditions. Fuel reliability and reactor production capacity are affected by this performance problem under normal reactor power operation. At present, costly power manoeuvering restrictions are required to minimize the occurrence of failure, in particular during rapid uprating of the core. The power ramp failure propensity has also some safety implications, namely the release of radioactivity, which must be considered in connection with an accidental rapid increase of core reactivity. Several power ramp test programs with different scopes and objectives have been, and are being, executed in parallel using the 50 MWth reactor R2. Up to now more than two hundred such fuel ramp tests have been performed. The more comprehensive investigations aim primarily at establishing the power ramp failure thresholds for normal type LWR fuel. Design and operational parameters are being varied. In general the results reveal a strong propensity to ramp failure of fuel rods that are subjected to large and fast "over-ramp" operations. The destructive mechanisms and other criteria relevant to the failure event are discussed. One comprehensive program of this type named the Studsvik Inter-Ramp Project, is now being executed as a joint international effort. Fourteen organizations participate representing fuel manufacturers, power reactor utilities and national research organizations in Europe, Japan and USA. Fuel design modifications and special operational modes aiming at suppressing the power ramp failure probability are also being investigated. Some of the approaches adopted seem quite promising as indicated by the results so far obtained.

41521 (IAEA-CN—36/322) **Physical and technical aspects of nuclear and chemical safety of APS with fast reactors cooled with N_2O_4.** Nesterenko, V.B.; Sharovarov, G.A.; Kovalev, S.D.; Trubnikov, V.P. (International Atomic Energy Agency, Vienna (Austria)). 1977. 11p. (In Russian). (CONF-770505—197). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

4.2.-.T.1./10 4 figs. Also available in English.

Analysis of the APS safety with gas-cooled fast reactors with N_2O_4 is given. On cooling a highly stressed reactor core by a gas coolant a number of complicated problems of nuclear safety occur. The main emergency processes caused by the leakage in facilities are considered and the advantages of a gas-liquid cycle application with N_2O_4 are pointed out. Using a gas-liquid cycle provides for two favourable features: a great deal of coolant in a circuit in the liquid phase permits the continuous movement of a coolant relative to flow rate to be achieved. On the rupture of the main tubing at the reactor inlet or outlet the pressure drop of the order of 16 bar in the circuit provides for cooling a core at the expense of coolant flowing between the sides of high and low pressure during the time sufficient for taking necessary actions to cool a reactor further. To decrease the loss of a coolant in the case of leakage a number of constructive precautions are provided on the decrease of flow rate through the emergency tubing, in particular an application of a multiloop scheme of cooling, the sectioning of equipment, etc. The description of emergency cooling systems and dynamics of damage is given. The proposals on the localization of emergency ejections of a coolant and removal of the failure consequences are presented.

41522 (IAEA-CN—36/393) **Reactivity requirements and safety systems for heavy water reactors.** Kati, S.L.; Rustagi, R.S.; Rastogi, B.P.; Ray, A.K.; Sahni, D.C.; Srivenkatesan, R. (International Atomic Energy Agency, Vienna (Austria)). 1977. 6p. (CONF-770505—178). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

4.1.-.T.2./09 3 tables, 2 figs.

The natural uranium fuelled pressurised heavy water reactors are currently being installed in India. In the design of nuclear reactors, adequate attention has to be given to the safety systems. In recent years, several design modifications having bearing on safety, in the reactor processes, protective and containment systems have been made. These have resulted either from new trends in safety and reliability standards or as a result of feed-back from operating reactors of this type. The significant areas of modifications that have been introduced in the design of Indian PHWR's are: sophisticated theoretical modelling of reactor accidents, reactivity control, two independent fast acting systems, full double containment and improved post-accident depressurisation and building clean-up. This paper brings out the evolution of design of safety systems for heavy water reactors. A short review of safety systems which have been used in different heavy water reactors, of varying sizes, has been made. In particular, the safety systems selected for the latest 235 MWe twin reactor unit station in Narora, in Northern India, have been discussed in detail. Research and Development efforts made in this connection are discussed. The experience of design and operation of the systems in Rajasthan and Kalpakkam reactors has also been outlined.

41523 (IAEA-CN—36/467) **Some problems of the safety of PWR nuclear power plants viewed from the technical standpoint.** Bilek, V. (International Atomic Energy Agency, Vienna (Austria)). 1977. 9p. (In Russian). (CONF-770505—163). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

4.1.-.T.2./03.

The paper presents the views of the Czechoslovak design organization on the solution of the technical problems associated with PWR core emergency cooling using pressure accumulators and a system of low-pressure pumps. An analysis is made of the method and the point of inlet of the water to the primary circuit from the accumulators and of the volume and working pressure of the latter. The technical problems of the containment systems in connection with supplementary reactor cooling are discussed. The different types are compared with respect to their functioning, and the requirements which they must fulfil in order to meet the design solution are given. The basic requirements which the design solution must satisfy so as to permit the use of diagnostic methods are also indicated.

41524 (IAEA-CN—36/512) **Safety considerations of PWR's.** Arnold, W.H. Jr. (International Atomic Energy Agency, Vienna (Austria)). 1977. 22p. (CONF-770505—162). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

4.1.-.T.2./02.

The safety of the central station pressurized water reactor is well established and substantiated by its excellent operating record. Operating data from 55 reactors of this type have established a record of safe operating history unparalleled by any modern large scale industry. The 186 plants under construction require a continuing commitment to maintain this outstanding record. The safety of the PWR has been further verified by the recently completed Reactor Safety Study ("Rasmussen" Report). Not only has this study confirmed the exceptionally low risk associated with PWR operation, it has also introduced a valuable new tool in the decision making process. PWR designs, utilizing the philosophy of defense in depth, provide the bases for evaluating margins of safety. The design of the reactor coolant system, the containment system, emergency core cooling system and other related systems and components provide substantial margins of safety under both normal and postulated accident conditions even considering simultaneous effects of earthquakes and other environmental phenomena.

41525 (IAEA-CN—36/541) **LWR safety research in the Federal Republic of Germany.** Seipel, H.G. (International Atomic Energy Agency, Vienna (Austria)). 1977. vp. (CONF-770505—157). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

4.1.-.T.3./01 This entry prepared from abstract.

The paper gives a review of the German LWR safety research programme. It describes how the programme was initiated and informs on its goals, development andpractical realization, and indicates how it is bound up with international collaboration. The contribution so far made by the programme to an enhancement of the understanding of major safety problems and to the improvement of safety technology is demonstrated by means of a few selected examples. Experiments relating to loss-of--coolant accidents have deepened the understanding of the heat transfer in the reactor core during blowdown as well as during the flooding phase. Investigations of the dynamic effects going on in dry full pressure containments and pressure suppression systems, following a loss-of--coolant accident, have indicated that existing computer models cannot satisfactorily predict all relevant physical phenomena. Yet, the experimental results obtained constitute a sufficient basis for safe containment design. Research work on core meltdown accidents has identified the particular importance of the type of concrete used for the containment structures and its foundation. If basaltic concrete is used, a substantial fission product release to the environment is extremely unlikely even in the case of a core meltdown accident. At least, it would take place much later than was previously assumed. Resrach on the safety of pressurized components has been concentrated on the problem of cracks in the heat-affected zone of welds. New methods were developed for the detection and analysis of the acceptability of microcrack fields. Additional investigations of specimens and components to increase the understanding of the long-term behaviour of components with microcracks are envisaged in the frame of a new major project on "component safety". Considerable progress has been made in the development of methods for automatic remote-control volumetric testing of reactor pressure vessels using ultrasonic techniques.

41526 (IAEA-CN—36/544) **Safety aspects and operating experience of LWR plants in Japan.** Aoki, S.; Yoshioka, T.; Toyota, M.; Hinoki, M. (International Atomic Energy Agency, Vienna (Austria)). 1977. 11p. (CONF-770505—151). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

4.1.-.T.1./12 2 tables, 1 fig.

From the outset of nuclear power development in Japan, major emphasis has been placed on the safety of the nuclear power plants. There are now twelve nuclear power plants in operation with a total output of 6600 MWe. Their operating records were generally satisfactory, but in the 1974 to 1975 period, they experienced somewhat declined availability due to the repair work under the specific circumstances. After investigation of causes of troubles countermeasures were made to ensure safety, and they are now keeping good performance. In Japan, nuclear power plants are strictly subject to sufficient and careful inspection in compliance with the safety regulation, and are placed under stringent radiation control of employees. Under the various circumstances, however, the period of annual inspection tends to be prolonged more than originally planned, and this consequently is considered to be one of the causes of reduced availability. In order to develop nuclear power generation for the future, it is necessary to put further emphasis on the assurance of safety and to endeavor to devise measures to improve availability of the plants, based on the careful analysis of causes which reduce plant availability. This paper discusses the results of studies made for the following items from such viewpoints: (1) Safety and Operating Experience of LWR Nuclear Power Plants in Japan; a) Operating experience with light water reactors b) Improvements in design of light water reactors during the past ten years c) Analysis of the factors which affect plant availability; 2) Assurance of Safety and Measures to Increase Availability a) Measures for safety and environmental protection b) Measures to reduce radiation exposure of employees c) Appropriateness of maintenance and inspection work d) Measures to increase plant availability e) Measures to improve reliability of equipments and components; and 3) Future Technical Problems.

41527 (IAEA-CN—36/551) **Evaluation of local accidents in LMFBR.** Kikuchi, Y.; Mizuta, H.; Yoshikawa, H.; Hori, M.; Tanaka, K. (International Atomic Energy Agency, Vienna (Austria)). 1977. 7p. (CONF-770505—192). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

4.2.-.T.1./07 1 table, 8 figs.

Evaluation of local failures in the LMFBR plant has been made through experiments and analyses. The evaluated subjects are the individual phenomena which are important for the safety analysis of the plant. The areas thus far studied are; the failures in a fuel subassembly --- fission gas release, sodium boiling, local flow blockage, local fuel-sodium interaction etc., and the failures in a steam generator --- small and large leak sodium-water reaction. Thermal and hydrodynamic effects of various abnormal conditions in a fuel subassembly are being evaluated from out-pile experiments. The simulation tests of fission-gas release from a fuel cladding defect were conducted to evaluate its mechanical and thermal effects. Sodium boiling phenomena were studied experimentally and the prediction by computer codes were in satisfactory agreement with the experimental results. For the understanding of local flow block-

age effect, the experiment and analysis are now in progress. Out-pile UO_2-Na interaction tests are being conducted to confirm the magnitude of generated pressure. The integrity of wrapper tube walls to that pressure was examined by gun-powder explosion tests using water. Various failure detection methods are being studied along with the above experiments. Effects of sodium-water reaction caused by small and large leak of water into sodium in a steam generator are also investigated. Extensive studies were conducted on the failure propagation by small leak. Integrity of the steam generator and secondary circuit components to large leak accident was examined.

41528 (IAEA-CN—36/560) **Safety analysis of the THTR-300 MW(e)-prototype-reactor and future HTR's under extreme accident conditions.** Kietzer, K.; Otto, K.W.; Petersen, K.; Weicht, U. (International Atomic Energy Agency, Vienna (Austria)). 1977. 7p. (CONF-770505—171). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

4.1.-.T.2./11.

In 1972 HRB, a subsidiary of BBC and General Atomic, began with the construction of the THTR-Prototype-Reactor. The RW-TUV Essen is appointed by the licensing authorities to supervise the safety of the nuclear power plant. A principal point of interest arising from the safety analysis and the demand to comply with the requirements of safety and reliability is the after-heat removal system which consists of 2x2 steam generator-blower units out of six used in normal operating conditions. In order to assess the safety margin of the plant, the total failure of all cooling systems was investigated. The investigation revealed that in case of all emergency cooling systems failing to operate after initiation of a reactor trip, natural convection starts to transport heat from the hotter parts of the circuit, especially from the core, to cooler parts such as reflectors, steam generator and vessel. However, the temperature rise throughout the primary system is extremely slow and surmounts critical values only after hours if no further actions are taken. The resumption of heat removal after, for instance, 5 hours can be accomplished without endangering the integrity of the relevant components if adequate procedures are conducted. The transient temperature behaviour of the core and of essential reactor components in case of the total failure of all after-heat removal systems was preliminarily investigated for the 3000 MWth pebble bed high-temperature reactor which is proposed by the German reactor development programme. It has been shown that: (1) there will be a period of several hours between the accident initiation and the occurence of irreversible damage to the reactor; and (2) even for the extreme hypothetical case of all active measures failing to operate, no essential damage of the core integrity is expected to occur, and important fisson product barriers remain intact.

41529 (IAEA-CN—36/572) **Safety of the liquid metal cooled fast breeder reactor and aspects of its fuel cycle.** Kessler, G.; Papp, R.; Huebel, D. (International Atomic Energy Agency, Vienna (Austria)). 1977. 13p. (CONF-770505—191). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

4.2.-.T.1./05.

A multilevel safety - or a defense in depth - approach is applied to the design and construction of fast power reactors. This multi-level safety approach takes into account: design measures for fail safe features of components, for redundancy, testability, inspectability and quality assurance; protection against anticipated and unlikely faults of components. This is assured by highly reliable protection devices (primary and secondary shut down system), decay heat removal systems, redundant and diverse instrumentation, etc.; containment measures against extremely unlikely faults such as large pipe ruptures, loss of cooling accidents, large sodium fires, large sodium water reactions, etc.; and design and containment measures against unlikely external events such as air plane crashes, seismic events, etc. All design data of the fast reactor plant are confirmed by extensive experimental programmes. Design limits of the plant are thoroughly discussed during the licensing process. Important safety R and D programmes such as the following were and still are being performed: the SEFOR experimental programme, for the behavior of LMFBR-cores under superprompt transient power excursions (Doppler coefficients); the SNEAK-programme for the measurement of core reactivity coefficients; the CABRI-programme for the burst behavior of LMFBR-fuel pins; the MOL-7C-programme for the investigation of local cooling failures in fuel elements and the detectability of fuel failures; the sodium boiling experimental program; experiments on sodium fires and aerosol behavior; and experiments on Na-H_2O-reactions in steam generators. A very conservative safety analysis for hypothetical core and other plant accidents is used for present prototype fast reactors. The future trend of development of theoretical methods for the accident analysis, and the application of experimental results is reviewed, especially in view to large commercial type LMFBR's.

41530 (IAEA-CN—36/584) **Summary of LWR safety research in the USA.** Murley, T.E.; Tong, L.S.; Bennett, G.L. (International Atomic Energy Agency, Vienna (Austria)). 1977. 38p. (CONF-770505—155). Dep. NTIS (US Sales Only), PC A03/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

4.1.-.T.3./10 131 refs., 40 figs.

The U.S. Nuclear Regulatory Commission's water reactor safety research program is described and the basic results are presented. The USNRC water reactor safety research program consists of five basic research areas: integrity of vessel and piping, thermal-hydraulic test, fuel rod behaviour, code development and verification, and reactor operational safety. Results from the vessel and piping integrity research have demonstrated the high safety margins in scaled vessels and the analytical procedures for calculating vessel behaviour under pressure. Non-destructive examination techniques are being improved. Work is also proceeding to define the material constituents to reduce the susceptibility of irradiation embrittlement and stress corrosion cracking. The thermal-hydraulic tests have covered the various phases of a hypothetical loss of coolant accident (LOCA) and activation of the emergency core cooling system (ECCS). These tests have led to the development of engineering correlations to describe the phenomena to further quantify the safety margins in commercial nuclear power plants. Specifically, this paper presents selected experimental data and analytical predictions from the initial tests in LOFT and SEMISCALE. Comparisons and evaluations are made between the data and analytical predictions. Significant results and conclusions are presented regarding the behaviour of emergency core cooling systems in a LOCA environment: the ability to predict LOCA-type experiments over a scaling range of thirty and the thermal-hydraulic behaviour of components such as pumps in an integral system LOCA environment. The fuel behaviour research has provided valuable information on decay heat, cladding oxidation, fuel rod behaviour and fuel metling. Both the decay heat and the cladding oxidation have been shown to be lower than assumed in the licensing evaluations.

41531 (IKE—2-33) **Literature search on slip and entrainment in a reactor cooling channel.** Beck, W.; Schuetzle, R. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Kernenergetik). Nov 1976. 69p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

37 figs.; 1 tab.; 62 refs.

Models and correlations are presented describing slip and entrainment during the refilling phase after a LOCA in a PWR. Their applicability is investigated for a computer program to comprehend the processes in a reactor cooling channel during the refilling phase of the core. The models of Levy provide no realistic data for the problem discussed. Bankoff and Jones seem to predict reasonable results. Their half empirical relation is valid for void fractions α up to α approximately 0.75. Empirical correlations are applicable in smaller α-regions. Some relations cannot be evaluated on account of unknown quantities. When entrainment is concerned, often only the critical gas velocity at the onset is stated. It varies strongly. The correlations, describing the entrainment E, defined by the gas-stream, along the vertical axis z, provide values for E between 0.6 and 0.7 after a characteristic ascent at $z = 0.5 - 0.6$. Restrictions are frequently unknown.

41532 (ORNL/NUREG/NSIC—131) **LMFBR safety. 3. Review of current issues and bibliography of literature (1972—1974).** Buchanan, J.R.; Keilholtz, G.W. (Oak Ridge National Lab., Tenn. (USA)). 24 Feb 1977. Contract W-7405-ENG-26;NRC-INA-40-551-75;NRC-INA-40-552-75. 495p. Dep. NTIS, PC A22/MF A01.

The report discusses the current status of liquid-metal fast breeder reactor (LMFBR) development and one of the principal safety issues, a hypothetical core-disruptive accident (HCDA). Bibliographic information on worldwide LMFBRs relative to the development of the breeder reactor as a safe source of nuclear power is presented for the period 1972 through 1974. The bibliography consists of approximately 1380 abstracts covering research and development and operating experiences leading up to the present design practices that are necessary for the licensing of breeder reactors. Key-word, author, and permuted-title indexes are included.

41533 (ORNL/NUREG/TM—90) **LMFBR Aerosol Release and Transport Program. Quarterly progress report for October—December 1976.** Fontana, M.H.; Kress, T.S. (Oak Ridge National Lab., Tenn. (USA)). 22 Feb 1977. Contract W-7405-ENG-26;NRC-INA-40-551-75;NRC-INA-40-552-75. 25p. Dep. NTIS, PC A03/MF A01.

The report summarizes progress under the Liquid-Metal Fast Breeder Reactor (LMFBR) Aerosol Release and Transport Program. The program is designed to investigate radionuclide release and transport from LMFBRs for reactor events of severity up to and including hypothetical core-disruptive accidents (HCDAs). Discussions include (1) progress in the activation of the ORNL capacitor discharge vaporization (CDV) system; (2) determination of size distribution of large CDV droplets; (3) progress in the design of an arc hearth furnace for UO_2 vaporization; (4) progress in the reactiva-

tion of the Nuclear Safety Pilot Plant (NSPP) for sodium burning tests; (5) progress in the design and construction of the Fuel-Aerosol Simulant Test (FAST) facility; and (6) analytical studies of UO_2 vapor bubble behavior.

41534 (ORNL/NUREG/TM—93) **Quarterly progress report on advanced two-phase instrumentation program for November—December 1976.** Sheppard, J.D.; Leavell, W.H.; Shahrokhi, F.; Wynn, M.C. (Oak Ridge National Lab., Tenn. (USA)). Mar 1977. Contract W-7405-ENG-26;NRC-INA-40-551-75;NRC-INA-40-552-75. 21p. Dep. NTIS, PC A03/MF A01.

A Venturi meter was tested as a two-phase momentum monitoring device in the ORNL air-water, two-phase flow facility. Void fraction was monitored at the Venturi inlet with a rotating electric field, conductance meter, and Venturi pressure drop was correlated with mixture momentum determined by a separated-flow model. A computer algorithm was developed to apply cross-correlation techniques to the measurement of nonstationary two-phase velocities. The algorithm was tested with computer-generated, two-phase velocity transients. Preliminary results show good agreement between algorithm estimates and the known velocities.

41535 (PB—254415) **Tornado missile risk analysis. Topical report No. 1.** Dunn, W.L.; Lew, S.T.; Davis, R.L.; Hsu, J.C.; McConnell, B.S. (Carolina Power and Light Co., Raleigh, N.C. (USA)). Jan 1976. 84p. NTIS $5.00.

Literature reviews, preliminary models, methodology descriptions, and general progress appraisal corresponding to the first 12 weeks of the research and approximately 14% of the budget expenditures are presented. Consequently, much of the methodology discussed in the various tasks is tentative and dependent upon further investigation as noted. The objective of this project is to develop a probabilistic formalism for characterizing the effects of the tornado generated missiles on the plant safety. The state-of-the-art nnd the R/D efforts needed to accomplish the stated objective are summarized.

41536 (PB—257567) **Study of radiation dosage to structural components in nuclear reactors. Final report.** Miller, L.B.; Jarka, R.E.; Kaul, D.C. (Science Applications, Inc., Rolling Meadows, Ill. (USA)). Jan 1976. 238p. NTIS $8.00.

This study was sponsored in order to provide the nuclear industry with an analysis of the radiation levels inside typical light water reactor pressure vessels with emphasis on those components designed to function the lifetime of the system. The report describes the calculation of the neutron and gamma ray fluxes and spectra determined by applying two dimensional radiation transport computer codes to physical models of a pressurized water reactor and a boiling water reactor. The calculated neutron and gamma ray distributions may be used to estimate the total radiation exposure to which a reactor component is exposed over a period of time for the two generic reactor systems studied. The accurate knowledge of these radiation levels can be used to estimate the safety and licensibility of the pressure vessel and in-vessel components.

41537 (PB—259188) **Probabilistic and statistical models for seismic risk analysis.** Veneziano, D. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Civil Engineering). Jul 1975. 156p. (MIT-CE-R—75-34). NTIS, PC A08/MF A01.

Also pub. as Seismic Design Decision Analysis-21. See also PB—259189.

A number of models for engineering seismic risk analysis are proposed and compared. In all cases, uncertainties are included both on the seismic demand at the site, and on the seismic resistance of the facility. Particular attention is given to the effects of inductive uncertainty on the model parameters, which is due to limited available information. These parameters include the mean occurrence rate of seismic events, the 'decay rate' of the frequency-site intensity law, the mean value and the variance of the resistance distribution. The results from the models are compared with currently used approximations, which are found to be unconservative. A numerical example is presented, dealing with the estimation of seismic risk for nuclear power plants located in Massachusetts.

41538 (UCRL—50045-76-4) **Reactor containment analysis for BWR suppression systems. Progress report, October—December 1976.** Bowman, B.R.; Edwards, L.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 17 Mar 1977. Contract W-7405-ENG-48. 27p. Dep. NTIS, PC A03/MF A01.

The principal goal for FY '77 is to provide two basic items to the NRC: (1) numerical simulations of air venting into water for three particular cases that abstractly model the Mark I- and Mark III-type pressure suppression systems, and (2) a documented computational tool or tools to model fluid dynamics involved in venting to a boiling water reactor (BWR) pressure suppression pool.

41539 **Common mode failure analysis.** Gangloff, W.C. (Westinghouse Electr Corp, Pittsburgh, Pa). *IEEE Trans. Power Appar. Syst.;* **PAS-94**: No. 1, 27-30(1975).

The state of the art is summarized as reliability engineers seek to extend the techniques to include multiple failures from a common cause (or in a common mode). Qualitative extensions of both the fault tree and the reliability block diagrams have been used to evaluate the adequacy of reactor protection circuitry for commercial power reactors.

41540 **Seismic analysis of vertical pumps enclosed in liquid filled containers.** McDonald, C.K. (Univ of Ala in Birmingham). *Am. Soc. Mech. Eng., [Pap.];* No. 75-PVP-56, vp(1975).

The practical dynamic seismic analysis of vertical pumps which are enclosed in liquid filled cylindrical containers is examined. The equations of motion are developed to account for the hydrodynamic coupling between the pump column and container. This hydrodynamic coupling causes the mass matrix to be nondiagonal. The effects of these nondiagonal terms on the frequencies, mode shapes, seismic induced bending stresses, and deflections are illustrated by practical examples. 5 refs.

41541 **Inelastic response of nuclear piping subjected to rupture forces.** Anderson, J.C.; Singh, A.K. (Univ of South Calif, Los Angeles). *Am. Soc. Mech. Eng., [Pap.];* No. 75-PVP-21, vp(1975).

A numerical procedure which can be used to evaluate the inelastic dynamic response of piping systems subjected to blowdown forces is described. The following finite elements are used to represent the piping system: bilinear beam element, bilinear curved beam element, and bilinear support element with an initial gap. The method is then used to evaluate the dynamic response of two typical segments of a main steamline. 6 refs.

41542 **Matrix exponential approach to dynamic response.** Bahar, L.Y.; Sinha, A.K. (United Eng and Constr Inc, Philadelpha, Pa). *Comput. Struct.;* **5**: No. 2-3, 159-165(Jun 1975).

The matrix exponential technique, widely used in modern control theory, is adapted as a direct integration procedure for predicting the dynamic response due to discrete inputs. A sample problem whose exact solution is known is solved analytically, and the response is compared with the Wilson method, as well as the matrix exponential. The method is then applied to the response of a nuclear structure subjected to an earthquake excitation. Results indicate that the matrix exponential method is well suited for problems where the input data is known in digitized form. 26 refs.

41543 **Exposure fire protection for floating nuclear power plants.** Caines, R.E. (Offshore Power Syst). *Fire Technol.;* **11**: No. 3, 175-183(Aug 1975).

It is stressed that the development of a nuclear power plant that will float on water, yet will remain in a stationary position, requires a reassessment of the type of protection available for exposure protection. The function of the external fire protection system designed to extinguish or control combustible liquid fires within the basin area and protect the plant against radiant heat fluxes from exposure fires more than 100 feet from the plant is discussed. 6 refs.

41544 **Effects of modeling variations on RELAP4. predictions of Standard Problem Five.** Fujita, N.; Irani, A.A.; Mecham, D.C.; Sawtelle, G.R. (Energy Inc, Idaho Falls, Idaho). *Am. Soc. Mech. Eng., [Pap.];* No. 76-WA/HT-52, 1-9(5 Dec 1975).

Standard Problem Five was Test S-02-8, one of the first blowdown heat transfer tests conducted in the Semiscale Mod-1 facility. The test was conducted for the purpose of investigating the thermal and hydraulic phenomena accompanying a hypothetical double ended cold leg break in a water-cooled system. Time step studies indicated that the implicit numeric solution used by RELAP4 is convergent even when a large maximum time step is used. Steam generator heat transfer was found to have negligible effect on the hydraulic response of the system while it did have a small effect on rod temperature response. A two or three volume downcomer does an adequate job with one-dimensional flow equations. Further description of flow in a three-dimensional region appears to require extension of the governing equations rather than fancy one-dimensional modeling schemes. Four or five core volumes are quite adequate for analyzing a LOCA. More detailed modeling in the core will uncover small variations in the local rod thermal response. It was concluded that the analytical techniques used do a very good job at predicting the complex phenomena associated with the blowdown heat transfer tests performed in the Semiscale facility.

41545 **Analysis of critical heat flux in flow reversal transients.** Smith, R.A.; Price, F.A.; Griffith, P. (Shell Dev Co, Houston, Tex). *Am. Soc. Mech. Eng., [Pap.];* No. 76-HT-TT, 1-6(1976).

A large inlet break Loss of Coolant Accident in a Pressurized Water Reactor (PWR) would cause the flow through the core to reverse within milliseconds. Currently approved methods of analysis conservatively assume that vapor blanketing of core heat transfer surfaces occurs upon this first reduction to zero flow. A coordinated experimental and analytical study was conducted to determine when and where the vapor blanketing or Critical Heat Flux (CHF) conditions actually do develop in constant pressure rapid flow reversals.

The results indicate that first occurrence of CHF is due not to low coolant velocities, but to flow stagnation in the channel interior with associated rapid channel voiding. Calculations indicate that good cooling should persist over large regions of the core for about 1 s longer than is currently assumed. 10 refs.

41546 Laminar natural convection about downward facing heated blunt bodies to liquid metals. Harpole, G.M.; Catton, I. (Univ of Calif, Los Angeles). *Am. Soc. Mech. Eng., [Pap.];* No. 76-HT-HH, 1-5(1976).

The laminar boundary layer equations for free convection over bodies of arbitrary shape (i.e., a three-term series expansion) and with arbitrary surface heat flux or surface temperature are solved in local Cartesian coordinates. Both two-dimensional bodies (e.g., horizontal cylinders) and axisymmetric bodies (e.g., spheres) with finite radii of curvature at their stagnation points are considered. A Blasius series expansion is applied to convert from partial to ordinary differential equations. An additional transformation removes the surface shape dependence and the surface heat flux or surface temperature dependence of the equations. A second-order-correct, finite-difference method is used to solve the resulting equations. Tables of results for low Prandtl numbers are presented, from which local Nusselt numbers can be computed. The work is connected with proposed designs for a core catcher as part of the post-accident heat removal and containment system in liquid-metal fast breeder reactors. 16 refs.

41547 Two-dimensional analysis of conduction-controlled rewetting with precursory cooling. Dua, S.S.; Tien, C.L. (Univ of Calif, Berkeley). *Am. Soc. Mech. Eng., [Pap.];* No. 76-HT-WW, 1-7(1976).

Precursory cooling refers to the cooling caused by the droplet-vapor mixture in the region immediately ahead of the wet front, and is described mathematically by two dimensionless constants which characterize its magnitude and the region of influence. The physical model developed to account for precursory cooling consists of an infinitely extended vertical surface with the dry region ahead of the wet front characterized by an exponentially decaying heat flux and the wet region behind the moving film-front associated with a constant heat transfer coefficient. Apart from the two dimensionless constants describing the extent of precursory cooling, the physical problem is characterized by three dimensionless groups: the Peclet number or the dimensionless wetting velocity, the Biot number and a dimensionless temperature. Limiting solutions for large and small Peclet numbers are obtained utilizing the Wiener-Hopf technique coupled with appropriate kernel substitutions. A semiempirical matching relation is then devised for the entire range of Peclet numbers. Existing experimental data with variable flow rates at atmospheric pressure are very closely correlated by the model. 21 refs.

41548 Sodium-water reaction test facility (SWAT-3). Shimazu, H.; Ukechi, K.; Sasakura, K.; Kusunoki, J. (Ishikawajima-Harima Heavy Ind Co, Jpn). *IHI Eng. Rev.;* **9**: No. 3, 81-92(Jul 1976).

In the development of the liquid metal cooled fast breeder reactor (LMFBR), the steam generator (SG) is considered one of the most important components. The Power Reactor and Nuclear Fuel Development Corporation (PNC) is now promoting the research and development of the SG system used with the prototype fast breeder reactor 'Monju'. In this research, the phenomena of the sodium-water reaction in the SG are the key which must be investigated for the solution of problems. The test facility (SWAT-3) simulating Monju's SG on the scale of 1/2.5 was designed, fabricated and installed by IHI at Oarai Engineering Center of PNC, its pre-operation being accomplished in February 1975. The purpose of SWAT-3 is summarized as follows: to perform an overall test on the safety of Monju'S SG and intermediate heat transport system under the design condition against sodium-water reaction accidents; and to investigate the damage of the SG structure caused by the sodium-water reaction, and the possibility of repair and recovery operations. 4 refs.

41549 Postaccident heat removal--1. heat transfer within an internally heated, nonboiling liquid layer. Baker, L. Jr.; Faw, R.E.; Kulacki, F.A. (Argonne Natl Lab, Ill). *Nucl. Sci. Eng.;* **61**: No. 2, 222-230(Oct 1976).

Correlations of experimental data on heat transfer from nonboiling, horizontal fluid layers with internal heat generation have been cast into a form suitable for analysis of postaccident heat removal in fast reactors. Available data on layers with equal boundary temperatures indicate that the downward heat transfer rate can be accounted for by conduction alone, while the upward heat transfer rate is largely controlled by convection. A new correlation is presented that applies to evaluation of upward and downward heat fluxes from an internally heated layer with unequal boundary temperatures. Analysis techniques are illustrated in an example calculation pertaining to layers of molten mixed-oxide fuel.

41550 Postaccident heat removal--2. heat transfer from an internally heated liquid to a melting solid. Faw, R.E.; Baker, L. Jr. (Argonne Natl Lab, Ill). *Nucl. Sci. Eng.;* **61**: No. 2, 231-238(Oct 1976).

Microwave heating has been used in studies of heat transfer from a horizontal layer of internally heated liquid to a melting solid. Experiments were designed to simulate heat transfer and meltthrough processes of importance in the analysis of postaccident heat removal capabilities of nuclear reactors. Experimentally measured heat fluxes and melting rates were consistent with a model based on downward heat transfer by conduction through a stagnant liquid layer and upward heat transfer augmented by natural convection. Melting and displacement of the barrier material occurred by upward-moving droplets randomly distributed across the melting surface. Results indicated that the melting and displacement process had no effect on the heat transfer process.

41551 Potential for penetration of a hot vapor jet into a subcooled liquid. Tsai, S.S.; Kazimi, M.S. (Brookhaven Natl Lab, Upton, NY). *Am. Soc. Mech. Eng., [Pap.];* No. 76-WA/HT-78, 1-5(5 Dec 1976).

In safety assessment of liquid metal fast breeder reactors, it is important to determine the behavior of jets of fuel or steel vapor (or two-phase mixture) that may reach the upper sodium plenum following a hypothetical core disruptive accident. A simplified model is developed to describe the vapor (or two-phase) penetration depth into a cold liquid. The penetration depth of the jet is found to decrease with increasing condensation heat flux and/or decreasing vapor mass velocity and heat of evaporation. The results for the penetration depth are found to be in good agreement with Kerney's experimental data. It is found that for conditions prevailing in reactor accidents, steel and fuel vapor would have lower potential for penetration into the sodium pool than water vapor into a water pool. The physical parameters that establish whether jet-like penetration or bubble-like expansion of vapor in a subcooled liquid are also identified.

41552 Stability of a submerged frozen crust. Epstein, M. (Argonne Natl Lab, Ill). *Am. Soc. Mech. Eng., [Pap.];* No. 76-WA/HT-81, 1-8(5 Dec 1976).

A quantitative description of the behavior of a submerged frozen UO$sub 2$ fuel layer is important to liquid metal fast breeder hypothetical core-disruptive accident analysis. The motion of an infinite, approximately plane, thin frozen crust growing between two different molten materials is examined on the basis of linearized hydrodynamic theory. The formulation parallels that of Rayleigh and Kelvin for the generation of waves at the plane interface between two different fluids. A simple criterion that gives the frozen crust thickness at the onset of instability is proposed. It is found that crust growth can prevent the development of the Rayleigh instability. 13 refs.

41553 Prediction of reflood heat transfer with standard loop programs. Solbrig, C.W.; Shumway, R.W. (Aerojet Nucl Co, Idaho Falls, Idaho). *Am. Soc. Mech. Eng., [Pap.];* No. 76-WA/HT-54, 1-7(5 Dec 1976).

The capability of various models in currently available all-purpose computer codes to realistically calculate core reflood is shown. RELAP4 calculations were made using both a homogeneous multi-volume model with and without slip and a single volume model with bubble rise to simulate a FLECHT experiment. The results show a need for inclusion of unequal velocity (dynamic slip) and unequal temperature effects as well as an improvement of the RELAP4 transition boiling logic if realistic as opposed to convervative calculational results are desired. 7 refs.

41554 Role of Taylor instability on sublimation of a horizontal slab of dry ice. Dhir, V.; Castle, J.; Catton, I. (Univ of Calif, Los Angeles). *Am. Soc. Mech. Eng., [Pap.];* No. 76-WA/HT-67, 1-12(5 Dec 1976).

Sublimation of a horizontal slab of dry ice ($congruent$190 K) placed beneath a pool of warm water or benzene was observed experimentally. Data for the heat transfer coefficient are obtained in both steady and quasi-static states. In steady state experiments the pool temperature was maintained constant by adjusting power to an electric immersion heater placed in the pool, whereas the quasi-steady data were obtained by noting the time rate of change of the enthalpy of the liquid. The agitation created by the rising CO$sub 2$ bubbles kept the pool temperature uniform during these experiments. The heat transfer coefficient data for this pseudo film boiling process are found to be strongly dependent on the pool temperature. In the temperature range of stable film boiling, the heat transfer coefficient depends on the laminar or turbulent nature of the gas film. An application of the study to the fast reactor hypothetical accident situations in which a pool of molten fuel may be formed on horitzontal steel surfaces is discussed. 17 refs.

41555 Properties of light water reactor core melts. Nazare, S.; Ondracek, G.; Schulz, B. (Kernforschungszentrum, Karlsruhe, Ger.). *Nucl. Technol.;* **32**: No. 3, 239-246(Mar 1977).

To describe the behavior of the molten core in the case of a loss-of-coolant accident with core melting, data on the properties of

such core melts are required. These properties are dependent on the composition and structure of the melts. Available experimental evidence was used to define four types of melts that would occur, depending on the oxidation potential of the environment. Theoretical and experimental results were reviewed with a view to estimating such properties as heat capacity, viscosity, and thermal conductivity.

41556 Mechanical response of UO_2 subjected to transient heating. Wrona, B.J. (Argonne National Lab., IL); Roberts, J.T.A.; Galvin, T.M.; Higgins, G.T. *Nucl. Technol.;* **32**: No. 3, 276-289(Mar 1977).

A direct-electrical-heating apparatus was utilized to perform fundamental experiments on short, unirradiated, unclad UO_2 pellet stacks to investigate the effect of varying the energy-deposition rate and energy level on the mechanical response of the fuel to transient heating. Results show that as the rate of energy input to the UO_2 pellet stacks increases, (a) the energy failure threshold decreases and (b) the areal melt fraction at failure decreases. Two significantly different regimes of fuel-motion behavior were observed above and below a threshold designated as the threshold of gross fuel motion. Above the threshold, this motion occurs by molten fuel release. Below the threshold, fuel deforms plastically by a creep mechanism.

ENERGY STORAGE

MAGNETIC

REFER ALSO TO CITATION(S) 42299, 42300

PUMPED HYDRO

41557 (AD-A—034538) **Dickey-Lincoln School Lakes hydrothermal model study; hydraulic laboratory investigation. Final report, Jul 1975—Jun 1976.** Dortch, M.S.; Loftis, B.; Fontane, D.G.; Wilhelms, S.C. (Army Engineer Waterways Experiment Station, Vicksburg, Miss. (USA)). Dec 1976. 77p. (WES-TR-H—76-22). NTIS, PC A05/MF A01.

A one-dimensional, vertically stratified, thermal simulation model was developed for prediction of temperature within and downstream from Dickey-Lincoln School Lakes. Two physical hydraulic models were used to obtain an improved understanding and description of the hydrodynamic response of the lakes to pumped-storage hydropower. An undistorted, 1:200-scale model of the Dickey Lake intake structures and local topography was used to determine the steady-state selective withdrawal and pumpback flow characteristics for various conditions. A highly distorted-scale model (1:3600 horizontal, 1:180 vertical) was used to simulate the entire dual reservoir system and to determine the response to dynamic, unsteady-state, density stratified flow. Information from the two physical models was used to modify existing algorithms and to develop new algorithms for the mathematical model. The mathematical model allows simulation of the hydrodynamic and heat exchange characteristics so that the thermal regimes within and downstream from the two lakes can be determined for various hydrologic and meteorologic conditions and various pumped-storage hydropower operations.

41558 (PB—254413) **Underground pumped storage research priorities. Technical planning study.** Willett, D.C. (Acres American, Inc., Buffalo, N.Y.). Apr 1976. 132p. NTIS $6.00.

The current status of underground pumped storage is examined to identify specific elements requiring developmental work to encourage the adoption of the concept by electric power utilities. Aspects reviewed include siting and site investigation, provision of access to the underground facilities, the excavation of the lower reservoir cavern, and the availability of the requisite rotating equipment. Primary areas recommended for developmental work include the adaption of mining technology to the lower cavern excavation, the development of hoist equipment capable of handling loads to 120 tons, and the extension of single-stage reversible pump turbine capability to the 2,460 foot (750-metre) to 3,280 foot (1,000-metre) head range.

41559 Waldeck II underground pumped-storage station. Richter, E. (Siemens, Erlangen, Ger). *Siemens-Z.;* **49**: No. 1, 9-14(Jan 1975). (In German).

In November 1974, after a construction period of five years, the first generating set of the Waldeck II pumped-storage station went into service. Siemens AG was responsible for the entire design and planning scheme, for the consulting service, and for construction supervision. The civil engineering work--in particular the cavern structures--and the single-shaft sets with pump, synchronous generator and turbine are of remarkable size. The construction and the electrical features of the station are described.

41560 Cascade start-up of generator-motors at pumped storage hydroelectric plants. Glebov, I.A.; Vasil'evskii, S.P.; Shulakov, N.V.; Klyuchnikov, A.T.; Trefilov, V.A. *Elektrichestvo;* No. 1, 49-54(Jan 1975). (In Russian).

Results of analog computer study of the cascade start-up of generator motors of pumped storage hydroelectric power plants 220 MW or more are presented giving recommendations for the practical use of these results in reliable start-ups when the currents are below their nominal values.

41561 Reconstruction of the pump storage station Bleiloch, East Germany, with simultaneous output increase. Kreher, K.; Grubitzsch, W.; Reinemann, K. (Pumpspeicherwerke, Dresden, E Ger). *Energietechnik;* **25**: No. 3, 103-107(Mar 1975). (In German).

A 40-year plant is considered. Its machinery is in need of repairs. The future lifetime of the spirals and pressure pipes is estimated. Damages and repairs of the turbine wheels are described.

41562 Pressure pulsations and spiral vibration when ventilating storage pumps. Grubitzsch, W. (Pumpspeicherwerke, Dresden, E Ger). *Energietechnik;* **25**: No. 3, 107-110(Mar 1975). (In German).

Vibration cracks were found in the pump spirals of a pump storage station. These cracks resulted from pressure pulses in the spiral. By changing the operating conditions within the critical operational phase it was possible to eliminate the causes for the high dynamic stress in the spirals.

41563 Waldeck II underground pumped-storage station. Richter, E. (Siemens, Power Gener and Distrib Div, Erlangen, Ger). *Siemens Rev.;* **42**: No. 6, 249-254(Jun 1975). (In November 1974, after a construction period of five years, the first generating set of the Waldeck).

41564 Dinorwic power station. Benn, T. *Energy Dig. (London) ;* **5**: No. 3, 38-39(Jun 1976).

The scheme is in Snowdonia--at Dinorwic, near Llanberis, North Wales, and, when fully operational in about 1981 will have a combined maximum electrical output of over 1800 MW. It will be the first underground power station to be commissioned by the Central Electricity Generating Board (CEGB). The Dinorwic scheme will be one of the largest pumped-storage power stations in the world, and the largest in Europe. Part of the scheme will be in the Snowdonia National Park, and special attention is being paid to its environmental aspects. Very little of the station will be visible. The power station itself will be deep underground beneath the mountains at the Old Dinorwic slate quarries near Llanberis. The lower reservoir will be formed from the lake of Llyn Peris, and the upper reservoir will be formed from the lake of Marchlyn Mawr. Both already exist but their capacity will be increased. The difference in height between the two lakes is some 500 m (1,640 ft), and this establishes the 'head' under which the hydro-electric machines will operate. The electrical interconnection with the National Grid will be by 400 kV cables, which will be run underground for six miles from the power station so that pylons are unnecessary. Each machine will have a capacity of 330 MVA at 500 rev/min when operating as a generator, and 300 MW, rotating at 500 rev/min in the other direction, when operating as a pump.

FLYWHEELS

41565 (N—76-27695) **Energy storage: feasibility study to collect, store and release energy from solar origin, using a kinetic battery stockage.** Tatry, B. (Centre National d'Etudes Spatiales, 31 - Toulouse (France)). Feb 1976. 21p. (In French). (CNES-NT—31). NTIS $3.50.

The feasibility of using solar energy to feed an autonomous station providing electric current continuously was studied. As an energy storage device a 'superflywheel' (rotor with composite fibers - magnetic bearings) would be used. Results show that such an experiment can be reasonably envisaged only in highly sunny countries and that it becomes non profitable at our latitudes, despite the very good performance of the flywheel storage device.

THERMAL

41566 (CEA-CONF—3638) **Underground storage of heat.** Despois, J.; Nougarede, F. (CEA Direction des Productions, 92 - Chatillon (France)). 1976. 14p. (In French). (CONF-7605137—1). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Annual meeting of the French Society of Heat Engineers) thermal aspects of actual energy problems; Grenoble, France (24 May 1976).

The interest in heat storage is envisaged in the new energy context, with a view to optimizing the use of production means of heat sources little modulated according to the demand. In such a way, a natural medium, without any construction cost but only an access cost is to be used. So, porous and permeable rocky strata allowing the use of a pressurized water flow as a transfer fluid are quite convenient. With such a choice high temperatures (200 deg C) may be obtained, that are suitable for long transmissions. A mathematical model intended for solving the conservation equations in the case of heat storage inside a confined water layer is discussed. An approach of the operating conditions of storage may involve either a line-up arrangement (with the hot drilling at the center, the cold drillings being aligned on both sides) or a radial arrangement (with cold drillings at the peripheral edge encircling the hot drilling at the center of the layer). The three principal problems encountered are: starting drilling, and the circuit insulation and control.

BATTERIES

DESIGN AND DEVELOPMENT

41567 (ANL—76-98) **High-performance batteries for off-peak energy storage and electric-vehicle propulsion. Progress report for the period July—September 1976.** (Argonne National Lab., Ill. (USA)). Dec 1976. Contract W-31-109-ENG-38. 63p. Dep. NTIS, PC A04/MF A01.

Research and management efforts on lithium—aluminum/metal sulfide batteries during the period July—September 1976 are described. These cells, which operate at 400—450°C, are vertically oriented, prismatic cells with a central positive electrode of FeS or FeS_2, two facing negative electrodes of lithium—aluminum alloy, and an electrolyte of molten LiCl—KCl. A market study and an economic analysis are being performed; cells, cell components, and battery testing equipment are being developed and fabricated by industrial firms under contract; and work is in progress on designs for a 30 kWh electric-vehicle battery and a module for a stationary energy storage battery. Cells fabricated by Eagle-Picher Industries, Inc. were tested as single cells and as two- and three-cell batteries. Design modifications based on evaluations of these tests are in progress. New electrode and cell designs are also being developed and tested at ANL. The concepts receiving major attention include the design of multiple-electrode cells, the fabrication of electrodes in the uncharged state, the use of carbon-bonded current-collector structures in the positive electrode, the fabrication of electrodes by hot-pressing active materials and electrolyte, and the use of additives to the negative electrode. Materials development efforts included optimization of designs of electrical feedthroughs; development of improved electrode separators, e.g., BN and Y_2O_3 felts; corrosion tests of construction materials; and postoperative examination of cells. A new type of liquid-lithium electrode, in which lithium from a pool is wicked to the positive electrode, was developed. Investigations of alternative cell systems included tests of small-scale Li/TiS_2 and $NaFeS_2$ cells; a larger-scale $CaMg_2$/FeS cell is also being operated. 22 figures, 5 tables.

41568 (N—76-28642) **Development and fabrication of large vented nickel—zinc cells. Final report.** Donnel, C.P.I. (Yardney Electric Corp., Pawcatuck, Conn. (USA)). Dec 1975. Contract NAS3-18515. 60p. (NASA-CR—134967). NTIS, PC A04/MF A01.

A preliminary cell design for a 300-Ah vented nickel—zinc cell was established based on volume requirements and cell component materials selected by NASA Lewis Research Center. A 100-Ah cell configuration was derived from the 300-Ah cell design utilizing the same size electrodes, separators, and cell terminal hardware. The first cells fabricated were four groups of three cells each in the 100-Ah size. These 100-Ah experimental nickel—zinc cells had as common components the nickel positive electrodes (GFM), flexible inorganic separator (GFM) bags on the negative electrodes, pressed powder zinc oxide electrodes, and cell containers with hardware. The variations introduced were four differing electrolyte absorber (interseparator) systems used to encase the nickel positive electrodes of each cell group. The four groups of 100-Ah experimental vented nickel—zinc cells were tested to determine, based on cell performance, the best two interseparator systems. Using the two interseparator systems, two groups of experimental 300-AH cells were fabricated. Each group of three cells differed only in the interseparator material used. The six cells were filled, formed and tested to evaluate the interseparator materials and investigate the performance characteristics of the 300-Ah cell configuration and its components. (auth)

41569 **Process for producing electric current by the electrochemical oxidation of an active anodic metal, especially zinc.** Doniat, D.; Porta, A.; Bugnet, B. (to Societe Anonyme Automobiles). US Patent 3,981,747. 21 Sep 1976. Priority date Aug 1971, France. 8p.

A process for producing electric current by the electrochemical oxidation of an active anodic metal dispersed in an alkaline electrolyte is described. The electrolyte is circulated into contact with a second metal which is more electronegative than the active metal. A displacement reaction precipitates the active metal from its soluble oxidation products. There is obtained as a result a repeated recovery for reuse of the active metal (zinc) with the aid of the more electronegative metal (aluminum), which then supplies the energy for the production of current and is oxidized to form soluble products. The process is exemplified by zinc as the active metal and aluminum and magnesium as the strongly electronegative metals. 1 fig.

41570 **Means for detecting and neutralizing leaks in electrochemical cells.** Hallett, J.L.; Rollason, P.H.; Rychlewski, T.V. (to GTE Sylvania Inc.). US Patent 4,011,371. 8 Mar 1977. Filed date 17 Dec 1975. 2p.

A neutralizing agent is maintained adjacent the seal area of electrochemical cells containing corrosive electrolytes. The neutralizing agent can be kept in a pocket or depression formed in a flange next to the seal or can be contained in a suitable plastic ring which surrounds the seal. When the electrolyte is thionyl chloride and aluminum chloride, a suitable neutralizing agent is sodium carbonate. 2 figs.

PERFORMANCE AND TESTING

41571 (N—76-24703) **Cadmium migration in aerospace nickel cadmium cells.** Mcdermott, P.P. (Coppin State Coll., Baltimore, Md. (USA)). Mar 1976. 32p. (NASA-CR—144753). NTIS $4.00.

The effects of temperature, the nature of separator material, charge and discharge, carbonate contamination, and the mode of storage are studied with respect to the migration of active material from the negative toward the positive plate. A theoretical model is proposed which takes into account the solubility of cadmium in various concentrations of hydroxide and carbonate at different temperatures, the generation of the cadmiate ion, $Cd(OH)_3^-$, during discharge, the migration of the cadmiate ion and particulate $Cd(OH)_2$ due to electrophoretic effects and the movement of electrolyte in and out of the negative plate and, finally, the recrystallization of cadmiate ion in the separator as $Cd(OH)_2$. Application of the theoretical model to observations of cadmium migration in cycled cells is also discussed.

41572 (N—76-27673) **Fabrication and testing of sealed silver—zinc cells. Final report.** Donnel, C.P.I. (Yardney Electric Corp., Pawcatuck, Conn. (USA)). Jun 1976. Contract NAS3-16805. 61p. (NASA-CR—135048). NTIS, PC A05/MF A01.

A number of Type HS40-7 sealed silver—zinc cells and experimental 40-Ah sealed silver—zinc cells were fabricated. Cells of each experimental group contained one variation from the standard configuration (HS40-7) cell. Cells from each of five experimental cell groups and cells of the standard configuration were tested to characterize voltage and capacity performance at various discharge rates. The test cells were then subjected to 100 percent DOD Cycle Life Testing at 22 C. Results indicate that material and/or process variations are available which will improve both performance and cycle life of the existing 40 ampere-hour sealed silver—zinc cell configurations. The average cycle life to 50 percent loss of nominal capacity in cells from two (2) of the experimental groups was 150—165 cycles. A series of 12 ampere-hour cells was fabricated and tested as part of a program to incorporate the 40-Ah sealed silver—zinc cell fabrication technology into a cell of smaller size. Base-line configuration cells and experimental variations were produced using the HS40-7 cell fabrication and processing methods adapted to the smaller cell size. (auth)

41573 **Anodic evolution of sulphur from sodium polysulphide melts. I. Voltammetric measurements on planar carbon electrodes.** Brennan, M.P.J. (Chloride Silent Power Ltd., Runcorn, Eng.). *Electrochim. Acta;* **22**: No. 3, 279-283(Mar 1977).

The anodic evolution of sulfur from sodium polysulfide melts was studied at planar vitreous carbon and pyrolytic graphite electrodes. A reaction mechanism is proposed, in which the primary product of the electrode reaction is a partly discharged polysulfide anion, which undergoes chemical reactions in the diffusion layer to form sulfur. Phase formation is primarily a homogeneous process which does not proceed to a passivating film of sulfur upon the electrode. At high cd nucleation can occur upon the electrode leading to passivation, but the sulfur formed in this way does not wet the electrode, and depassivation can occur spontaneously. 10 figures, 2 tables.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 41573

41574 (AD-D—003275) **Battery wedge for submarines or other installations.** Mongillo, A.V. (Environmental Protection Agency, Denver, Colo. (USA)). 6 Oct 1976. 15p. NTIS, PC A02/MF A01.

The patent application relates to a wedge assembly for spacing apart batteries which permits a complete range of operation with all components remaining intact in their assembled form. A central or inner wedge having a plurality of identical wedge sections is movable between a pair of outer wedges or side plates having mating inner sections and a planar outer surface. Wedging action is produced by torquing a bolt secured to the outer wedges and threaded through a nut secured in the inner wedge. The wedging components are held together and in alignment by screws attached to the inner wedge and guided through slots formed in the outer wedges.

41575 (N—76-27697) **Hermetic covers for European Ni/Cd cells.** Montalenti, P. (European Space Research and Technology Centre, Noordwijk (Netherlands)). Jan 1976. 35p. NTIS, PC A03/MF A01.

Various designs and technologies used in covers of European Ni/Cd battery cells are reviewed. Failure modes and test procedures for the assessment of failure modes are evaluated as the first part of a qualification program for the covers of Ni/Cd cells to be used in future European satellites. Electrochemical corrosion as failure mode, potentio-dynamic scanning as test criterion, and nickel plating as protection technique are highlighted. (auth)

41576 (N—76-28648) **Life capability of the silver electrode in alkaline electrochemical cells.** Frank, H.A. (Jet Propulsion Lab., Pasadena, Calif. (USA)). 1 Aug 1976. Contract NAS7-100. 38p. (NASA-CR—148485;JPL-TM—33-789). NTIS, PC A03/MF A01.

Estimates of silver electrode degradation rates were made by comparing the recently measured capacities with the reported early life capacities. Chemical analyses were carried out to determine the extent of silver loss from the electrode and its distribution throughout the cell components. The results established that the silver electrode is very stable when stored at reduced temperatures in the range of 0 to -51 C, in which it exhibits a permanent degradation in capacity of 0.5%/year. The results also indicated that the silver electrode is not quite as stable when operated and stored at room temperature, where it exhibits permanent degradation in the range of 3% to 14%/year. These results were employed in predicting the life capability of the proposed new Ag—H_2 cell and also in assessing the merits of employing silver electrodes in long-life probe batteries.

41577 **Metallic sulfide additives for positive electrode material within a secondary electrochemical cell.** Walsh, W.J.; McPheeters, C.C.; Yao, N.P.; Koura, K. (to Energy Research and Development Administration). US Patent 3,992,222. 16 Nov 1976. Filed date 15 Jul 1975. 10p.

PAT-APPL-596,044.

An improved active material for use within the positive electrode of a secondary electrochemical cell includes a mixture of iron disulfide and a sulfide of a polyvalent metal. Various metal sulfides, particularly sulfides of cobalt, nickel, copper, cerium and manganese, are added in minor weight proportion in respect to iron disulfide for improving the electrode performance and reducing current collector requirements. 5 fig., 4 tables.

41578 **Oxygen evolution on semiconducting oxides.** Tseung, A.C.C.; Jasem, S. (City Univ., London). *Electrochim. Acta;* **22**: No. 1, 31-34(Jan 1977).

The oxygen evolution reaction is of particular interest to secondary metal—air batteries and water electrolysis plants. However, most of the earlier work has been on precious metals, and there are no guidelines for the choice of semiconducting oxides as oxygen-evolving electrodes. In this study, the role of the metal/metal oxide or the lower metal oxide/higher metal oxide couple in determining the minimum voltage required for the evolution of oxygen is emphasized, together with other essential requirements such as electrical resistivity, electrode microstructure, corrosion resistance, and catalytic properties. A survey of various metal oxides based on the above criterion suggested that $NiCo_2O_4$ is of particular interest, and Teflon-bonded electrodes based on this material gave over 13,000 A/m² at 1.63 V vs dhe, 70°C, 5 N KOH. 6 figures, 1 table.

41579 **Effect of additives on lithium cycling in propylene carbonate.** Rauh, R.D.; Brummer, S.B. (EIC Corp., Newton, MA). *Electrochim. Acta;* **22**: No. 1, 75-83(Jan 1977).

Deposition and discharge of lithium on an inert (nickel) substrate in 1 M $LiClO_4$/propylene carbonate (PC) was studied as a function of plating and stripping currents, cycle number, and electrolyte composition. Water (less than 0.06 M), nitromethane, and SO_2 were found to enhance the cycling efficiency, which was relatively low in the dry electrolyte without additives. In all cases, marked deterioration in efficiency was noted after 10 to 20 repeated cycles. Electro-deposited lithium became unavailable for electrochemical stripping initially (over the first 10,000 s of its life) at an average rate of 30 to 40 μA/cm², essentially independent of the additive. This rate of capacity loss decreases with time, and reaches a limiting value of 5 to 10 μA/cm². This rate is also not improved by presence of additives. A mechanism of loss of efficiency during lithium cycling and also on open circuit stand was formulated: granules of lithium are encapsulated by an insulating film of PC—lithium reaction products; electrical contact with the substrate is thus severed. The additives are postulated to form Li^+-conductive films on the deposit, and thus allow deposition onto the granules and their growth into larger granules. On open circuit stand, the long-term equilibrium favors the formation of an insoluble insulating (Li—PC) film over the Li^+-conductive film. It is suggested that such behavior limits the usefulness of propylene carbonate in secondary lithium batteries. 9 figures, 2 tables.

41580 **Effect of additives on lithium cycling in methyl acetate.** Rauh, R.D.; Brummer, S.B. (EIC Corp., Newton, MA). *Electrochim. Acta;* **22**: No. 1, 85-91(Jan 1977).

Methyl acetate (MA) was examined as a solvent for use in nonaqueous secondary lithium batteries. The efficiency of cycling lithium on nickel in MA/1 M $LiClO_4$ containing less than 10 ppM H_2O was less than 10 percent. Addition of nitromethane (NM), SO_2 or small amounts of H_2O improved the efficiency markedly. Compared to propylene carbonate (PC), MA plus SO_2 or NM afforded more repeated cycles before failure of the working electrode. Unlike PC, the open-circuit lithium disappearance rate in MA is decreased in the presence of additives, e.g., from about 300 μA/cm²—70 μA/cm² with greater than 0.2 M nitromethane, and to essentially 0 μA/cm², under the proper conditions, with 3 M SO_2. The differences in behavior between PC and MA are attributed to the greater solubility of the MA—lithium reaction products, allowing greater opportunity for buildup of additive-induced conductive films on the metallic deposit. 11 figures.

ENERGY MANAGEMENT AND POLICY

SYSTEMS STUDIES AND TOTAL ENERGY

REFER ALSO TO CITATION(S) 41161, 41180, 41630, 41654, 41657

41581 (PB—254163) **Directory of Federal Energy Data Sources. Computer products and recurring publications.** (Federal Energy Administration, Washington, D.C. (USA)). May 1976. 84p. (FEA/B—76/219). NTIS $5.00.

The purpose of this directory is to announce two major types of Federally-sponsored energy-related information: energy information on magnetic tape and recurring publications which contain energy-related numerical data. The information on magnetic tape is primarily in the form of data files. However, there are also computer programs, data base reference services, and mathematical models. The items are listed under broad subject categories. The citations include title, responsible agency, dates of coverage, accession number, availability information, and abstract. Each entry is indexed by subject, originating agency, and accession number.

41582 (PB—254315) **Information on international research and development activities in the field of energy.** Hersey, D.F. (Smithsonian Science Information Exchange, Inc., Washington, D.C. (USA)). May 1976. 370p. NTIS $10.50.

This directory is the product of a data collection effort undertaken by the Smithsonian Science Information Exchange (SSIE) on behalf of an interagency committee formed under the U.S. State Department to provide international cooperation in energy research and development. Included is information covering 1766 ongoing and recently completed energy research projects conducted in Canada, Italy, the Federal Republic of Germany, France, the Netherlands, the United Kingdom, and 25 other countries. In addition to the title and text of project summaries, the directory contains the following indexes: Subject Index, Investigator Index, Performing Organization Index, and Supporting Organization Index.

41583 (PB—254564) **A qualitative study of consumer attitudes toward energy conservation.** (Bee Angell and Associates, Inc., Chicago, Ill. (USA)). Nov 1975. 52p. NTIS $4.50.

See also PB—244979 and PB—244980.

The findings represent the qualitative assessment of attitudes that were explored and obtained in different regions of the country from a broadly-based cross-section of the population. The intent of the project was not to suggest either a definitive or an exhaustive data base. Rather, the task was viewed as directional. As such, its intent was to provide stimuli for the formulation of hypotheses based upon the exploration of attitudes, first-hand, by utilizing valid and reliable qualitative research techniques.

41584 (PB—255949) **Critical post-1985 energy policy issues.** Meadows, D.L.; Ford, F.A.; Naill, R. (Dartmouth Coll., Hanover, N.H. (USA). Dartmouth Systems Dynamics Group). Jul 1975. Contract FEA-P-03-75-7328-0. 73p. (DSD—35). NTIS $4.50.

The report given identifies eight interdisciplinary issues requiring the most careful analysis because of their fundamental importance to energy policy. The report also identifies six issues which

demonstrate a variety of justifications for formulating energy policy in the context of post-1985 considerations. A taxonomy of energy issues is developed and used to identify the extent to which nine policy areas receive too little or too much attention.

ECONOMICS AND SOCIOLOGY

REFER ALSO TO CITATION(S) 41590, 41591, 41599, 41604, 41609, 41610, 41611, 41630, 41631, 41635, 41638, 41645, 41649, 41652

41585 (NSF-RA—760006, pp 65-69) **Psychology of earth-covered buildings.** Paulus, P.B. (Univ. of Texas, Arlington). 14 Jul 1976.

From Conference on alternatives in energy conservation: the use of earth covered buildings; Fort Worth, TX, USA (9 Jul 1975).

In Alternatives in energy conservation: the use of earth covered buildings.

Although little specific research on the psychological effects of earth-covered structures is available, a number of possible psychological effects are suggested. The earth covering and low level of noise of underground structures were seen as features having potentially positive psychological effects. However, while being underground and in a windowless environment may have some potentially positive psychological effects, these features appear to be primarily negative in terms of psychological impact. Much research is, of course, required to examine more definitively the suggestions offered in this paper. Special attention should be paid to important individual differences in reactions to underground environments, such as need for complexity or stimulation. One final point merits consideration: one might be able to deal with emotional problems produced in certain environments by adding features to the environment that are known to produce opposite emotional effects. For example, if an underground environment produces too low a level of arousal, one might be able to increase this arousal by use of various color schemes or wall-size murals depicting various scenes. Mehrabian and Russell have presented evidence that feelings of arousal and pleasure are affected differently by various colors. Hence, once one knows which emotion (pleasure, arousal, or dominance) needs to be modified, one could select a certain color scheme or scenery which has been shown to produce desired increase or decrease in the emotion for use in the environment in question. In fact, Sommer (1974) found that occupants of underground environments may initiate such changes in their environments on their own. He also suggests the use of surrogate windows such as fish tanks or terraria, plants and flowers, posters, and an atrium that would span several floors and provide daylight to lower floors.

41586 (PB—255731) **Effect of changing input and product prices on the demand for irrigation water in Texas. Technical report.** Lacewell, R.D.; Condra, G.D. (Texas Agricultural and Mechanical Univ., College Station (USA). Water Resources Inst.). Jun 1976. Contracts DI-14-31-0001-5044;DI-14-34-0001-6045. 39p. NTIS $4.00.

Several studies were done on the Texas High Plains relative to the effect of increasing input prices (natural gas, diesel, and nitrogen) on irrigated agriculture, given alternative crop prices. A linear programming model was developed and applied. The results indicate use of diesel is not very sensitive to price up to about $1.38 per gallon, while nitrogen use is very sensitive to price changes. The research emphasized natural gas price increases and suggests, fairly significant irrigated agricultural changes begin to occur at a natural gas price of just over $2.00 mfc. Irrigated acres begin to decline, production declines and farmer net returns decline. This carries serious implications for economic viability of the average farm firm in the region. (GRA)

ENVIRONMENT, HEALTH, AND SAFETY

REFER ALSO TO CITATION(S) 40852, 40859, 40860, 40861, 40991, 41585, 41609, 41612, 41614, 41615, 41616, 41633, 41642, 41649, 41652, 41696, 41990

41587 (AD-A—026597) **Observations on ecology and national security. Final technical note.** Ford, J.J. (Stanford Research Inst., Menlo Park, Calif. (USA). Strategic Studies Center). Mar 1975. Contract DAHC15-73-C-0380. 91p. (SSC-TN—2625-12). NTIS $5.00.

Indications of an impending systemic ecological crisis--such as world population growth, mounting demands on finite mineral resources, and pollution of the biosphere--have led to increased concern with the ecological determinants of international economic affairs. The report reveals that there is a serious mismatch between the scope and complexity of these issues and U.S. practice to perform an ad hoc planning response options in connection with crisis situations. The study concludes that national security policy research must address ecological issues to provide proper consideration of the impact of ecological factors on security planning and policy development. The formulation of courses of action including technological measures is discussed. (GRA)

41588 (NSF-RA—760006, pp 7-19) **Use of earth covered buildings through history.** Labs, K. (Washington Univ., St. Louis). 14 Jul 1976.

From Conference on alternatives in energy conservation: the use of earth covered buildings; Fort Worth, TX, USA (9 Jul 1975).

In Alternatives in energy conservation: the use of earth covered buildings.

The use of underground space is thought to be as old as mankind itself. A survey of both ancient and modern uses reveals a multitude of reasons for developing the underground, among which are as a response to: availability of building materials; climate (now expressed as energy conservation); defensive needs (natural and human antagonists); local (site) circumstance; intensification of land use (multiple levels); aesthetic or formal concerns; ceremonial, symbolic intentions; nature conservation (ecological); and landscape preservation (visual). The main emphasis of early historical examples is related most closely to the fundamental shelter function of protection—from the elements, from seasonal extremes, and from hostile neighbors. These frequently were coincident with symbolic and religious considerations. Seldom are the benefits of underground construction exclusive of one another; indeed, as with any architectural solution, the underground alternative most often has been selected when a multiplicity of these benefits could be captured. To illustrate some varied benefits of underground space, developments at Matmata, Northern and Western China, Seripe, Kivas, rock-cut churches, and urban underground areas are cited. History reveals that the use of underground space promises a future of great potential. (MCW)

41589 (NSF-RA—760006, pp 151-164) **Urban geotecture: the invisible features of the civic profile.** Horsbrugh, P. (Univ. of Notre Dame, IN). 14 Jul 1976.

From Conference on alternatives in energy conservation: the use of earth covered buildings; Fort Worth, TX, USA (9 Jul 1975).

In Alternatives in energy conservation: the use of earth covered buildings.

Underground architecture has existed for as long as human records have existed. Economic circumstances are now forcing a reexamination of geospacial potentialities to assess anew the variety of experiences gained in the scientific context of energy production, consumption, and conservation. Geotecture, the author suggests, is the concept and practice of subterranean spatial construction of any kind, at any depth, providing service or accommodation for any purpose. The author emphasizes three particularities of Urban Geotecture as an essential measure of urban design prudence and municipal economy. (1) The fundamental importance of the nature of the crust of the Earth is ignored by all but the most specialist engineer—it is taken for granted. (2) The concepts of solid geometry, "that include all three dimensions of space in its reasoning" seem to be cultivated in vacuum rather than in solidarity. (3) The training and practice of urban planning has proceeded, seemingly without challenge, in its most total preoccupation with the planning of the horizontal plane. The author emphasizes this domination of plane over volume and concludes it is the major hindrance in the geotectural design process. He also concludes that this is the first highly technical society that is searching the Earth for spatial relief. (MCW)

41590 (NSF-RA—760006, pp 165-181) **Utilities for underground structures.** Meyer, K.T. (Snowden and Meyers, Inc., Austin, TX). 14 Jul 1976.

From Conference on alternatives in energy conservation: the use of earth covered buildings; Fort Worth, TX, USA (9 Jul 1975).

In Alternatives in energy conservation: the use of earth covered buildings.

Considerations of utility service for underground structures are presented with emphasis on drainage and sewerage. Topics include clear water vs. solids-carrying water, pumping vs. gravity flow, typical technology for accomplishing wastewater pumping including costs, construction approaches, and serviceability. Deep utility main construction is covered, including considerations of cut and cover vs. tunneling, again with descriptions, cost comparisons, environmental and neighborhood impact being analyzed. Small-diameter horizontal-bore techniques are described. An extensive description of the Austin Crosstown Interceptor Tunnel, including purpose, routing, cost effectiveness, design and investigative approaches, and construction aspects, concludes the presentation.

41591 (NSF-RA—760006, pp 183-210) **Alternative to suburbia.** Moreland, F.L. (Univ. of Texas, Arlington). 14 Jul 1976.

From Conference on alternatives in energy conservation: the use of earth covered buildings; Fort Worth, TX, USA (9 Jul 1975).

In Alternatives in energy conservation: the use of earth covered buildings.

After reviewing what was always thought to be the main alternative for suburbia (high rise buildings), the author soon realized

that earth-covered neighborhoods could be an alternative and also maintain many desirable features the populace was searching for—privacy and open space at dwellings. Other criteria for an acceptable alternative to suburbia included: (1) visual and acoustic privacy for each dwelling, (2) proximity to public transit, (3) close proximity to private and community green areas, and (4) opportunity for ownership, etc. In this paper the author examines the viability of earth-covered housing from a consumer perspective. Such examinations are well known to be full of hazards, and this one is no different. It is less well known that, occasionally, such examinations are also useful. The population examined here constitutes a major component of the market for new, and potentially privately owned dwellings, i.e., couples aged 25 to 45, with children, with incomes in the $10,000.00 to $40,000.00 range, who live in major metropolitan areas--typical candidates for suburbia. The scheme here is to cast the considerations of a consumer in a context that reveals his goals and their relative importance, and to speculate about how well various alternatives meet the goals. The format for the considerations will be a decision matrix. Decision Matrix I is a representation of the considerations of a "typical" consumer in, say, 1972. Decision Matrix II relates to a consumer in the 1980 period. The hypothetical 1980 matrix suggests that earth covered housing may be a viable alternative. (MCW)

41592 (NSF-RA—760006, pp 211-232) **Build without destroying the Earth.** Wells, M.B. 14 Jul 1976.

From Conference on alternatives in energy conservation: the use of earth covered buildings; Fort Worth, TX, USA (9 Jul 1975).

In Alternatives in energy conservation: the use of earth covered buildings.

The author reviews the evolution of his concept of underground construction since first viewing, as a child, a concrete pedestal with a wild garden on its top. Later, he observed that the open garden in the shadow of the wild garden was not affected by the hot summer heat. So, the notion of impaling structures on hillsides or constructing them underground developed. After reviewing various structures with which he has been associated (community in Raven Rocks, Ohio; the Cary Arboretum of the New York Botanical Garden), the author says he dreams for a "series of little communities on the lower slopes of some mesas in a huge western tract of which 95 percent will be left wild. Cars will be virtually barred, food will be grown on certain flood plains, and all other energy will be gathered from the Sun and the wind. The nicest part of all is that because conventional zoning will be replaced here by ecological zoning, many of the units can be built tiny enough to drive their costs down into the range of the average, low-to-middle-income buyer." One long-range proposal designed to make use of the economy of factory fabrication and the environmental stability of hundred-year earth-shells would allow factory-made, well-insulated room components to be plugged (and unplugged and recycled) at will without ever having to disturb again the slowly healing earth-wounds atop the sheltering structures. An office building today could be a hospital tomorrow with none of the tearing up of land usually associated with major construction work. (MCW)

41593 (NSF-RA—760006, pp 247-256) **Air quality and heat transfer.** Spiegel, W.F. 14 Jul 1976.

From Conference on alternatives in energy conservation: the use of earth covered buildings; Fort Worth, TX, USA (9 Jul 1975).

In Alternatives in energy conservation: the use of earth covered buildings.

Whatever the primary considerations may be for the selection of an earth-covered configuration for a building, there is the obvious benefit of relative freedom from large external variations of temperature and other environmental factors. Potentially, there are some very attractive energy-saving opportunities in an earth-covered structure; practically, there are a number of parameters which warrant careful consideration, lest the designer falls into some of the same traps which lead to energy waste in conventional buildings. The challenge is to identify the cases where the earth cover is significant from a heat transfer point of view. There is, perhaps, more variation with different types of configuration and geographic locality that affect the environmental considerations of earth-covered structures than there is between such structures and conventional buildings. Some of the basic heat-transfer and ventilation concepts are reviewed The ventilation, lighting system, heat contributed from people, space conditioning, and any solar load are issues briefly discussed. There are two points to be emphasized: (1) whether a facility be earth-covered or covered with anything else, the same general principles that govern energy conservation in normal structures must be considered; and (2) if the peripheral effects that normally influence the skin of a building can be minimized or removed, such as in an earth-covered building, and if general principles of energy conservation are considered, then an earth-covered building can be made to be very energy-efficient indeed. (MCW)

41594 (NSF-RA—760006, pp 257-262) **Soil and ground water considerations.** Lytton, R.L. (Texas A and M Univ., College Station). 14 Jul 1976.

From Conference on alternatives in energy conservation: the use of earth covered buildings; Fort Worth, TX, USA (9 Jul 1975).

In Alternatives in energy conservation: the use of earth covered buildings.

The geotechnical issues discussed concern geology (faults, seismic zones, clastic mass, sedimentary zones, and subsidence); ground water (water table and aquifer); soils (settlement, bearing capacity, stability, and exploration techniques); construction techniques (tunneling and innovations); building performance (utility line corrections and humidity); and selection criteria for soil condition. The conditions considered for this criteria are diggable soils, flat slopes, bedrock below soils, seismically quiet, low water table, and arable land. Some brief Don'ts are summarized in appendix II. (MCW)

41595 (NSF-RA—760006, pp 269-278) **Earth-covered buildings and environmental impact.** LaNier, R. (Univ. of Wisconsin, Milwaukee). 14 Jul 1976.

From Conference on alternatives in energy conservation: the use of earth covered buildings; Fort Worth, TX, USA (9 Jul 1975).

In Alternatives in energy conservation: the use of earth covered buildings.

The paper examines the project impact analysis and also the cumulative potential environmental impact resulting from a broad expansion of the use of earth-covered buildings. The principal benefit of earth-covered buildings may well be the fact that the ground surface remains open. Depending upon the particular site characteristics, the significance of this fact will vary considerably. Preservation of a particular open space may be of aesthetic or historical significance or scarce open land may be needed as a park, playground, a civic plaza, or for other public activities. In such cases the negative impacts of an earth-covered building would be considerably less than any surface structure. Significant negative impact can be anticipated as a result of additional excavation. The most critical direct impact would be the increased stream sediment loads, but indirect impacts would also result from the practice of filling wet land areas with excavated materials. The major positive benefits would be related to decreased thermal pollution levels which should result from the decreased energy demands which should follow the use of earth-covered buildings. At the micro-scale the most important environmental benefit of earth-covered buildings is the potential uses of the surface area. The most significant environmental impacts will probably be those derived from the decision of how to use this space. Determination of broader environmental impacts must be at the macro scale. With regards to the potential effects of various land-use alternatives, temperature, precipitation, wind, and humidity are discussed individually. The primary conclusions to be drawn from this review of potential impacts are that reductions in energy utilization may be the most promising aspect to pursue. Consequently, it is recommended that urban energy budget studies be undertaken in a number of communities of varying size and physical layout. (MCW)

41596 (NSF-RA—760006, pp 279-303) **Effect of ground cover on Earth temperature.** Kusuda, T. (National Bureau of Standards, Washington, DC). 14 Jul 1976.

From Conference on alternatives in energy conservation: the use of earth covered buildings; Fort Worth, TX, USA (9 Jul 1975).

Presented by B.A. Peavy.

In Alternatives in energy conservation: the use of earth covered buildings.

The temperature data as a function of time and depth adjacent to underground or earth-covered structures are needed for evaluation of heat transfer in the Earth from time of occupancy. The parameters that affect variations in earth temperature at depths down to about 50 feet can be classified into three groups: geographic, site, and earth properties. A particular parameter that has not been previously investigated is the effect on earth temperature variations by different types of ground cover with different heat absorbing characteristics for incident solar radiation. Presented in this paper are results of an earth temperature study conducted at a site on the grounds of the National Bureau of Standards. This program was sponsored by the Office of Civil Defense in order to improve the existing thermal design information particularly in relation to properties such as the type of surface overlying the earth, to solar radiation, and surface weather conditions. Five patches of 50′ x 50′ were designated and prepared to represent five different surface conditions: asphalt-covered surface to a depth of 5 inches unpainted and a similar area painted white; bare soil; grass-covered surface left unmoved and another maintained at 4 inches. Results show that temperature in the earth is affected by the nature of ground surface cover. The annual variation as well as the average temperature under the high heat-absorbing surface (black asphalt) is higher than the lower heat-absorbing (grass covered) surfaces. The ground surface temperature became lower than the ambient air temperature during summer nights with a clear sky except for the black asphalt surface, which soaked up too much heat during the previous daytime hours to be sufficiently cooled. The diurnal temperature wave did

not penetrate beyond the two-foot depth. The annual wave did reach the 30-foot depth. By using a least squares technique, the thermal diffusivity of the Earth was estimated to be 0.02 ft^2/h. (MCW)

41597 (PB—255142) **Index of EPA legal authority. Statutes and legislative history, Executive orders, regulations.** (Environmental Protection Agency, Washington, D.C. (USA). Office of the Administrator). Jan 1974. 283p. NTIS $9.25.

The purpose of this Index is to provide a legally cited listing of all the statutes with their legislative histories, executive orders, regulations, and guidelines and reports, that are currently applicable to the U.S. Environmental Protection Agency. It is a quick reference source as well as providing the citations to enable one to obtain the actual material. The Index is divided into seven major divisions: General, Air, Water, Solid waste, Pesticides, Radiation, and Noise. Each major division is subdivided into groupings of Statutes and legislative history, Executive orders, Regulations, and Guidelines and reports. (GRA)

41598 (PB—258191) **A review of the U.S. Environmental Protection Agency environmental research outlook, fiscal year 1976 through 1980.** (Office of Technology Assessment (U.S. Congress), Washington, D.C.). Aug 1976. 116p. (OTA-E—32). NTIS $5.50.

The Environmental Protection Agency (EPA), in presenting to Congress for the first time a 5-year plan for environmental research and development activities, has taken an important step toward expanding the public dialog necessary to identify and establish national environmental goals. The Plan emphasizes the development and demonstration of control technologies. In many cases, larger problems involve social, economic, and institutional patterns which not only impede technical solutions but which require nontechnical approaches. (GRA)

41599 **Modeling the economic and environmental consequences of alternative energy policies.** Doggett, R.M.; Meyer, R.; Narkus-Kramer, M.; Noble, S.B.; Stern, M.O. (International Research and Tech., Arlington, VA). pp 943-948 of In Proceedings of the 1976 summer computer simulation conference. La Jolla, CA; Simulation Councils, Inc. (1976).

From Summer computer simulation conference; Washington, District of Columbia, United States of America (USA) (12 Jul 1976).

See CONF-760703—.

SEAS, the Strategic Environmental Assessment System, was originally conceived by the Environmental Protection Agency (EPA) as an analytical tool which could indicate the implications of Federal environmental regulations by measuring both the direct impacts on air and water quality and the indirect effects of pollution-control investment on the national economy. The qualities of the system which has been developed reflect this commitment to integrated assessment. Some of the major characteristics can be summarized. The model is geared to conduct analysis at a very detailed level, by employing information from a number of large existing data bases. A wide array of scenario and override capabilities are included in the system design, permitting the investigation and comparison of alternative futures. At the same time the model, through use of an input-output structure, feedback mechanisms, and interrelationships between system submodules, has sought to create an internal consistency within the projective framework, so that an adjustment to a primary causal variable is felt throughout the system. A brief review of these principles is presented as an introduction to the current energy effort.

ENERGY RESOURCES

41600 (NTISUB/B—027-76/001) **Energy information report to Congress required by Public Law 93-319, amended by Public Law 94-163. First quarter 1976.** (Federal Energy Administration, Washington, D.C. (USA)). 1976. 136p. (FEA/B—76/156). NTIS $10.00.

See also PB—242760-04.

Resource development, coal, natural gas, crude oil, refined petroleum products, nuclear energy, and electric power are discussed. Topic areas cover such things as production, consumption, imports, exports, and reserves. (GRA)

41601 (NTISUB/B—127-76/006) **Monthly energy review, June 1976.** (Federal Energy Administration, Washington, D.C. (USA)). Jun 1976. 85p. (FEA/B—76/285). NTIS $4.00.

See also NTISUB/B—127-76/005.

Tables, graphs, and data dealing with production, consumption, and prices of crude oil, natural gas, coal, and petroleum products are presented. Also reviewed are U.S. nuclear powerplant operations. (GRA)

41602 (NTISUB/B—127-76/007) **Monthly energy review.** (Federal Energy Administration, Washington, D.C. (USA)). Jul 1976. 86p. (FEA/B—76/329). NTIS $4.00.

See also NTISUB/B/127-76/006.

Tables, graphs, and data dealing with production, consumption, and prices of crude oil, natural gas, coal, and petroleum products are presented. (GRA)

RESEARCH AND DEVELOPMENT

REFER ALSO TO CITATION(S) 41166

41603 (PB—254188) **Technology assessment and forecast. Sixth report.** (Patent and Trademark Office, Washington, D.C. (USA)). Jun 1976. 190p. (PAT—036.3-7606). NTIS $7.50.

See also rept. No. 5, COM—75-11142.

The document reviews 15 technologies which are the subject of heavy patenting by foreign resident inventors and 22 technologies with high patent activity. Included are seven special reports prepared by patent examiners in such subjects as catalytic treatment of exhaust gases, four channel sound systems and surface acoustic wave devices. Patent activity is reviewed in solar energy technology, the production of energy from waste material, and wind generation of electricity. Economic activity and patent activity are compared in six industries.

NUCLEAR ENERGY

REFER ALSO TO CITATION(S) 41142, 41377, 41631

41604 (ORAU/IEA(M)—76-15) **Nontechnical issues associated with LMFBR energy centers.** Barkenbus, J.N.; Reister, D.B. (Institute for Energy Analysis, Oak Ridge, Tenn. (USA)). Jan 1977. Contract W-7405-ENG-26;SUB-81734. 43p. (ORNL/Sub/81734—76/1). Dep. NTIS, PC A03/MF A01.

Nuclear energy centers, consisting of LMFBRs with associated fuel-cycle facilities, may possess siting advantages over the more-traditional dispersed nuclear plant siting practice. There are, however, numerous institutional or non-technical barriers facing development of such nuclear energy centers in the future. In assessing these barriers, the key actors in the decision-making process are identified, namely, the utilities, the government, and the public at large. The most salient obstacles to implementation, from the perspective of each of the above, are identified and discussed. It is suggested that strong opinions held by a segment of the public, against the construction of such energy facilities, are likely to represent the largest single obstacle to their establishment. Finally, government policies that might decrease the extent of opposition toward nuclear center development are examined. (auth)

CONSERVATION

REFER ALSO TO CITATION(S) 41588, 41592, 41633

41605 (N—76-28203) **Cost/benefit trade-offs for reducing the energy consumption of commercial air transportation (RECAT). Final report.** Gobetz, F.W.; Dubin, A.P. (United Technologies Research Center, East Hartford, Conn. (USA)). Jun 1976. Contract NAS2-8608. 200p. (NASA-CR—138877;UTRC—R76-912036-16). NTIS $7.50.

A study was performed to evaluate the opportunities for reducing the energy requirements of the U.S. domestic air passenger transport system through improved operational techniques, modified in-service aircraft, derivatives of current production models, or new aircraft using either current or advanced technology. Each of the fuel-conserving alternatives was investigated individually to test its potential for fuel conservation relative to a hypothetical baseline case in which current, in-production aircraft types are assumed to operate, without modification and with current operational techniques, into the future out to the year 2000. (GRA)

41606 (N—76-28204) **Cost/benefit trade-offs for reducing the energy consumption of commercial air transportation (RECAT). Summary report.** Gobetz, F.W.; Leshane, A.A. (United Technologies Research Center, East Hartford, Conn. (USA)). Jun 1976. Contract NAS2-8608. 43p. (NASA-CR—137878;UTRC—R76-912036-17). NTIS $4.00.

The RECAT study evaluated the opportunities for reducing the energy requirements of the U.S. domestic air-passenger transport system through improved operational techniques, modified in-service aircraft, derivatives of current production models, or new aircraft using either current or advanced technology. Each of these fuel-conserving alternatives was investigated individually to test its potential for fuel conservation relative to a hypothetical baseline case in which current, in-production aircraft types are assumed to operate, without modification and with current operational tech-

niques, into the future out to the year 2000. Consequently, while the RECAT results lend insight into the directions in which technology can best be pursued for improved air-transport fuel economy, no single option studied in the RECAT program is indicative of a realistic future scenario. (GRA)

41607 (N—76-31079) **Study of cost/benefit tradeoffs for reducing the energy consumption of the commercial air transportation system.** Coykendall, R.E.; Curry, J.K.; Domke, A.E.; Madsen, S.E. (United Air Lines, Inc., San Francisco, Calif. (USA)). Jun 1976. Contract NAS2-8625. 194p. (NASA-CR—137891). NTIS $7.50.

Economic studies were conducted for three general fuel-conserving options: (1) improving fuel-consumption characteristics of existing aircraft via retrofit modifications; (2) introducing fuel-efficient derivations of existing production aircraft and/or introducing fuel efficient, current state-of-the-art new aircraft; and (3) introducing an advanced state-of-the-art turboprop airplane. These studies were designed to produce an optimum airline fleet mix for the years 1980, 1985 and 1990. The fleet selected accommodated a normal growth market by introducing somewhat larger aircraft while solving for maximum departure frequencies and a minimum load factor corresponding to a 15% investment hurdle rate. Fuel burnt per available-seat-mile flown would drop 22% from 1980 to 1990 due to the use of more fuel efficient aircraft designs, larger average aircraft size, and increased seating density. An inflight survey was taken to determine air traveler attitudes towards a new generation of advanced turboprops. (Author) (GRA)

41608 (N—76-31090) **Effect of aircraft technology improvements on intercity energy use. Final report.** (Aerospace Corp., El Segundo, Calif. (USA). Energy and Transportation Div.). May 1976. Contract NAS2-6473. 108p. (NASA-CR—137940;ATR—76(7310)-1). NTIS $5.50.

An examination of the growth or decline in energy consumption in short-haul, high-density intercity transportation is made in relation to changes in aeronautical technology. Improvements or changes in the technology of competitive modes are also included. Certain improvements in air traffic control procedures were included to determine their effectiveness in saving energy along with a fuel efficient turboprop short-haul aircraft concept. (Author) (GRA)

41609 (NSF-RA—760006) **Alternatives in energy conservation: the use of earth covered buildings.** Moreland, F.L. (ed.). (National Research Council, Washington, D.C. (USA)). 14 Jul 1976. 362p. (CONF-750770—). GPO $3.25.

From Conference on alternatives in energy conservation the use of earth covered buildings; Fort Worth, Texas, United States of America (USA) (9 Jul 1975).

Abstracts were prepared for 18 of the 25 papers presented at the conference on the use of earth-covered buildings, their costs, and their benefits. It is felt that earth-covered buildings will serve to provide both energy-efficient buildings and a better physical environment. An extensive bibliography (about 525 references) for the entire conference covering 18 subjects is included, in addition to the references with each paper. (MCW)

41610 (NSF-RA—760006, pp 43-64) **Comparative life cycle costs.** Williams, J.E. (Georgia Inst. of Tech., Atlanta). 14 Jul 1976.

From Conference on alternatives in energy conservation: the use of earth covered buildings; Fort Worth, TX, USA (9 Jul 1975).

In Alternatives in energy conservation: the use of earth covered buildings.

With the evolution of energy conservation as a national policy objective, earth-covered buildings may become viable competitors with their above-grade counter parts for housing human and mechanized activities. Persuasive arguments suggesting dramatic energy and maintenance cost savings cite reductions in excess of 90 percent for specific underground installations. The results are, of course, unique to each case and can only be generalized to the extent that other pertinent factors are considered. Prominent among these is the total cost of building ownership, commonly termed life-cycle cost (LCC). LCC techniques, when applied to buildings, illustrate the relative merits of alternatives based on planning, design, construction, operation, maintenance, renovation, and occupancy costs for various economic horizons. The intent here is (1) to outline a conceptual framework which facilitates comparison of such costs for above- and below-grade buildings and (2) to examine the sensitivity of the respective estimated total costs to variable energy rates, planning intervals, interest rates, and levels of initial and long-term investment. The resultant evidence is speculative by definition, directed toward the future potential and not the past performance of underground space.

41611 (NSF-RA—760006, pp 79-84) **New energy economics and the role of energy conservation in buildings.** Leighton, G.S. (Energy Research and Development Administration, Washington, DC). 14 Jul 1976.

From Conference on alternatives in energy conservation: the use of earth covered buildings; Fort Worth, TX, USA (9 Jul 1975).

In Alternatives in energy conservation: the use of earth covered buildings.

After briefly reviewing the energy situation as it is seen on a Federal level, Mr. Leighton summarizes the Administration's program to free the U.S. from excessive dependence on foreign oil (from the January 15, 1975, State-of-the-Union address). He then reviews the statistics of energy consumption in the building sector, which reveal this as the most important area for energy conservation practices. Remedial measures will involve improvements in operating procedures for buildings and appliances, energy efficiency of equipment and appliances, and energy efficiency of buildings themselves. Studies have shown that as much as 40 percent of the energy consumed in these areas is wasted. The highlights of the energy programs at FEA and ERDA are summarized, and the programs in nine additional agencies are briefly mentioned. It is concluded that energy conservation can be developed and implemented only with the cooperation of the public and private sectors. (MCW)

41612 (NSF-RA—760006, pp 85-105) **Comparison of energy consumption in earth-covered vs. non-earth-covered buildings.** Bligh, T. (Univ. of Minnesota, Minneapolis). 14 Jul 1976.

From Conference on alternatives in energy conservation: the use of earth covered buildings; Fort Worth, TX, USA (9 Jul 1975).

In Alternatives in energy conservation: the use of earth covered buildings.

Underground and earth-covered construction offers a real and significant opportunity for saving energy and for preserving valuable land resources. These methods lend themselves to mass production techniques without the adverse effects of endless visible repetition and can effect an energy savings of 75 percent or more.

41613 (NSF-RA—760006, pp 107-115) **Study of earth-covered buildings by an electric utility company.** Alders, C.A. (Texas Electric Service Co., Fort Worth). 14 Jul 1976.

From Conference on alternatives in energy conservation: the use of earth covered buildings; Fort Worth, TX, USA (9 Jul 1975).

In Alternatives in energy conservation: the use of earth covered buildings.

In an effort to reduce energy consumption in buildings, some consideration is being given to the effect of placing a building below grade. The idea behind this principle is to reduce the transmission load through the building shell, and thus, lower the energy consumption of the heating and cooling system. This report is presented as a theoretical analysis of energy usage for a typical office building (about 25,000 square feet) in this area placed above or below ground. Unfortunately, there is little data available on ground-temperature profiles, but some reasonable estimates for design-load-calculation purposes could be made from recommendations in the ASHRAE handbook. For energy-usage estimates, a range of high, low, and average ground-temperature profiles were used to determine the effect on heating and cooling loads. The values of temperatures used for both design and energy-usage considerations are tabulated. It was felt that the temperature-range approach would reflect whether or not ground temperature would make an appreciable difference in the overall energy consumption in the building.

41614 (NSF-RA—760006, pp 117-130) **University of Minnesota book store.** Bennett, D.J. (B-R-W, Inc., Edina, MI). 14 Jul 1976.

From Conference on alternatives in energy conservation: the use of earth covered buildings; Fort Worth, TX, USA (9 Jul 1975).

In Alternatives in energy conservation: the use of earth covered buildings.

An analysis of the 250 by 250-ft-square open space, where a bookstore was to be constructed, revealed that an underground structure would be most desirable. This paper describes the design process of the East Bank Bookstore/Admissions and Records Building, an 83,000-ft^2 mixed-occupancy facility, 95 percent of which is below grade level. The building design not only featured energy-conservation measures, but served a socio-psychological demension. As a result of the energy-conservation design effort invested in this earth-covered shelter, it is estimated that the net energy saving—as measured by decreased fuel demand—will vary 50 to 100 percent during the heating season and from 10 to 50 percent during the cooling season, depending upon the loads imposed by lighting and people. (MCW)

41615 (NSF-RA—760006, pp 131-134) **University of Houston student center.** Golemon, H.A. 14 Jul 1976.

From Conference on alternatives in energy conservation: the use of earth covered buildings; Fort Worth, TX, USA (9 Jul 1975).

In Alternatives in energy conservation: the use of earth covered buildings.

After examining the choices available for the addition of or expanding the needed space at the University of Houston Student Center, the architects decided to go underground. The structure houses a large commuter and international lounge, snack bar, crafts studios, student association offices, and a variety of other things to support student activities. It is all linked underground to the sunken courtyard of the existing building, and the roof is a landscaped plaza

designed for student rallies and concerts. The slightly higher cost of the underground scheme was more than offset by its many advantages. Cost statistics and design details are briefly described. (MCW)

41616 (NSF-RA—760006, pp 135-149) **Terraset Elementary School, Reston, Virginia.** Carter, D. (Davis, Smith and Carter, Inc., Reston, VA). 14 Jul 1976.

From Conference on alternatives in energy conservation: the use of earth covered buildings; Fort Worth, TX, USA (9 Jul 1975).

In Alternatives in energy conservation: the use of earth covered buildings.

The proposed design of the underground, solar-heated school in Reston, Virginia, is discussed. Basically the school is designed to serve both educational and community needs. The gymnasium and administrative areas above the entrance courtyard, and the multipurpose hall and kitchen areas below the courtyard, and the multipurpose hall and kitchen areas below the courtyard can be divided off from the main school area both functionally and mechanically. Mechanically of course to avoid operating the main air handling units during non-school hours. Both administration and multi-purpose hall open onto the courtyard to allow maximum orientation to the outdoor environment. Should the current trend towards open and flexible spaces be reversed, the ceiling design, and indeed the floor plan itself, are such that the school could be divided into fully enclosed classrooms. The intent was to design an energy-conservation building which would not detract from the functional layout. Terraset is a 990-student open-plan school of some 66,000 net square feet, designed to very explicit educational specifications. The program was then fixed. After describing the lighting and ventilation systems, the environmental impact and the cost, the mechanical system with its tubular glass evacuated solar collector is described. The advantages of this panel installation are listed. It provides the following advantages: (1) good insulation (depending on the state of vacuum achieved); (2) undistorted vision; (3) collector plates which can track either manually or automatically, and at the same time act as venetian blinds to eliminate solar heat build-up in the enclosed space due to radiation. Payback period for the collector system will be eight years when compared to an all-electric conventional system. (MCW)

41617 (PB—254304) **Public attitudes and behavior regarding energy conservation: detailed tabulations by U.S. population and population segments. Waves 5 and 6.** Rappeport, M.; Labaw, P. (Opinion Research Corp., Princeton, N.J. (USA)). Aug 1975. Contract DI-14-01-0001-1714. 38p. NTIS $4.00.

See also PB—245828.

The report given contains tabulations of results of telephone interviews on the public's attitudes towards: the Nation's dependence on oil imports; a possible natural gas shortage this winter; and the overall need to save energy. Interviews were conducted during the period of August 4 to August 29, 1975, on a sample of 1,020 adults age 18 or over.

41618 (PB—254305) **Public attitudes and behavior regarding energy conservation: detailed tabulations by U.S. population and population segments. Waves 20 and 21.** Rappeport, M.; Labaw, P. (Opinion Research Corp., Princeton, N.J. (USA)). Jan 1975. Contract DI-14-01-0001-1714. 27p. NTIS $4.00.

See also PB—244985.

The report given contains tabulations of results of telephone interviews on the public's attitudes on the following topics: (1) trends in attitudes and behavior resulting from issues surrounding the energy shortage; (2) fuel use as it affects attitudes and behavior; (3) public willingness to pay for the environment.

41619 (PB—254588) **Public attitudes and behavior regarding energy conservation: detailed tabulations by U.S. population segments; Waves 26 and 27. Monthly tabulated report.** Rappeport, M.; Labaw, P. (Opinion Research Corp., Princeton, N.J. (USA)). Apr 1975. Contract DI-14-01-0001-1714. 33p. NTIS, PC A03/MF A01.

See also PB—244988.

This report contains tabulations of results of telephone interviews conducted by Opinion Research Corporation on the public's attitudes toward the following topics: responsibility for conservation of natural resources; public awareness of FEA; attitudes and behavior related to daylight savings time; automobile usage and attitudes toward alternatives; and insulation of homes among the general public. The interviewing period for Wave 26 began on March 10 and continued through March 21, 1975. There were 604 interviews gathered on Wave 26. The interviewing for Wave 27 began on March 24 and ended on April 6, 1975. Six hundred and four interviews were also obtained on Wave 27.

41620 (PB—254589) **Public attitudes and behavior regarding energy conservation: detailed tabulations by U.S. population segments; Waves 22 and 23.** Rappeport, M.; Labaw, P. (Opinion Research Corp., Princeton, N.J. (USA)). Feb 1975. Contract DI-14-01-0001-1714. 35p. NTIS $4.00.

See also PB—244986.

This report contains tabulations of results of telephone interviews conducted by Opinion Research Corporation on the public's attitudes towards the following topics: role of rebates to encourage installation of storm windows and insulation; attitudes toward gasoline use and gas taxes; appliance purchases; and attitudes toward returnable bottles and cans. A total of 608 interviews were conducted for Wave 23 and 603 interviews for Wave 22, during the period January 13 to February 9, 1975.

41621 (PB—254590) **Public attitudes and behavior regarding energy conservation: detailed tabulations by U.S. population segments; Waves 7 and 8. Monthly tabulated report.** Rappeport, M.; Labaw, P. (Opinion Research Corp., Princeton, N.J. (USA)). Sep 1975. Contract DI-14-01-0001-1714. 57p. NTIS $4.50.

This report contains tabulations of the results of telephone interviews conducted by Opinion Research Corporation from September 16 to September 28, 1975 on the public's attitudes towards conservation of energy in the home and consumption and conservation of natural gas. Interviews were conducted with 604 adults, aged 18 and over.

41622 (PB—254591) **Public attitudes and behavior regarding energy conservation: detailed tabulations by U.S. population segments; Waves 3 and 4. Monthly tabulated report.** Rappeport, M.; Labaw, P. (Opinion Research Corp., Princeton, N.J. (USA)). Aug 1975. Contract DI-14-01-0001-1714. 33p. NTIS $4.00.

See also PB—246076.

This report contains tabulations of results of telephone interviews conducted by Opinion Research Corporation on automobile usage patterns. The interviewing period for Waves 3 and 4 extended from July 7 to August 4, 1975. A total of 1,007 interviews were obtained.

41623 (PB—254628) **Conservation of energy in the home. Highlight report, Volume XVII. Monthly report.** Rappeport, M.; Labaw, P. (Opinion Research Corp., Princeton, N.J. (USA)). Sep 1975. Contract FEA-CO-04-50236-00. 12p. NTIS $3.50.

See also Volume 16, PB—249544.

Public behavior and attitudes toward conserving home heating fuel, gasoline, electricity, and hot water are surveyed.

41624 (PB—254639) **Group discussions regarding consumer energy conservation.** (Gallup Organization, Inc., Princeton, N.J. (USA)). 26 Mar 1976. Contract FEA-CO-04-60426-00. 50p. NTIS $4.00.

The results of a series of group discussions conducted to investigate consumer attitudes and motivations as they relate to energy conservation are described. Specifically, the study was designed to cast light on the following questions: (1) the background climate of opinion that acts as a frame of reference for energy conservation communications; (2) classification of consumers in terms of adherence to or rejection of a conservation ethic; (3) the relation of energy waste and conservation to the standard of living aspirations of Americans; (4) the dominant kinds of motivations that are likely to influence receptivity to communications designed to promote energy conservation; (5) compatibility of counter-culture values with the conservation ethic; (6) kinds of beliefs held regarding the future role of alternative energy sources; (7) the likely effectiveness of economic incentives to energy conservation; (8) differences between teenager and pre-teen attitudes from adult attitudes.

41625 (PB—255003) **Public attitudes and behavior regarding energy conservation: Detailed tabulations by U.S. population and population segments, Waves 1 and 2.** Rappeport, M.; Labaw, P. (Opinion Research Corp., Princeton, N.J. (USA)). Jun 1975. Contract DI-14-01-0001-1714. 38p. NTIS $4.00.

See also report dated Aug 1975, PB—244990.

Tabulations of results of telephone interviews conducted by Opinion Research Corporation on the attitudes and behavior patterns of poor and/or elderly people as they relate to the current energy situation and as they compare to the attitudes and behavior of the public in general are presented. Two waves of interviewing were conducted by telephone during the period May 31 - June 22, 1975. There were 1222 interviews gathered among the total public on waves 1 and 2 combined. Of these, 382 were conducted with people whose family incomes are under $10,000, and 372 were conducted with people 50 years of age and older.

41626 (PB—256182) **First quarterly report to U.S. house and senate committees on appropriations.** (Federal Energy Administration, Washington, D.C. (USA). Office of Energy Conservation and Environment). Apr 1976. 35p. (FEA/D—76/364). NTIS $4.00.

This is the first of a series of quarterly reports to the House and Senate Committees on Appropriations describing the progress of the Federal Energy Administration's (FEA) energy conservation programs and short- and long-term accomplishments in terms of the dollar and energy savings that result from the programs. Part A, Overview, of this report discusses the rationale underlying the selection and design of the programs, briefly describes the major

programs, and summarizes the estimated short- and long-term dollar and energy savings and costs associated with the major programs. Part B, Highlights, reports the current status of the programs, including indicators of energy conservation achieved to date and major activities conducted during the quarter. Part C lists major publications.

SUPPLY, DEMAND, AND FORECASTING

REFER ALSO TO CITATION(S) 41635, 41636, 41637, 41653

41627 (IA—1327) **Guidelines for forecasting energy demand.** Sonnino, T. (Israel Atomic Energy Commission, Tel Aviv). Nov 1976. 22p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Four methodologies for forecasting energy demand are reviewed after considering the role of energy in the economy and the analysis of energy use in different economic sectors. The special case of Israel is considered throughout, and some forecasts for energy demands in the year 2000 are presented. An energy supply mix that may be considered feasible is proposed. (auth)

41628 (IAEA-CN—36/581) **Energy in developing countries: prospects and problems.** Baum, V. (International Atomic Energy Agency, Vienna (Austria)). 1977. 17p. (CONF-770505—235). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

1.A.-.P.1./03.

This paper analyses requirements for primary energy and electric power in the developing countries in the light of projections of population and economic growth. It evaluates the availability of indigenous energy resources and focuses on input requirements (capital, technology, trained personnel) for accelerated energy development; it reviews possible supplies for such inputs from domestic sources, transnational corporations, multilateral institutions, and through co-operation among the developing countries themselves and between the developing and the developed countries. The paper analyses the findings of the United Nations study "The Future of the World Economy. A Study on the Impact of the Prospective Economic Issues and Policies on the International Development Strategy" as far as they relate to energy and the developing countries in the light of the objectives of the Declaration on the Establishment of a New International Economic Order.

41629 (PB—257914) **Development of methods for forecasting the national industrial demand for energy. Final report.** (Econometrica International, Santa Barbara, Calif. (USA)). Jul 1976. 116p. NTIS $5.50.

This report develops a theoretical model to be used for forecasting energy demand by individual industries; it also discusses alternative specifications of functional forms in the theoretical model and implements the model using data for several two-digit (SIC) industries. (GRA)

41630 **Methodological survey of energy modeling.** De Bartolo, G. (Electric Power Research Inst., Palo Alto, CA). pp 743-746 of In Proceedings of the 1976 summer computer simulation conference. La Jolla, CA; Simulation Councils, Inc. (1976).

From Summer computer simulation conference; Washington, District of Columbia, United States of America (USA) (12 Jul 1976).

See CONF-760703—.

The number of energy models is sufficiently large and fast-growing as to make it impossible to describe individual models in detail in a short survey. Accordingly, in this survey the special characteristics of the energy sector and the ways in which some of those characteristics are incorporated in four of the major energy models are discussed. Familiar as the major characteristics of the energy sector are to energy modelers, it is worthwhile restating them in the context of a survey article. The relevant characteristics are: the energy sector is large. (In terms of consumption, the value of energy consumption in the U.S. in 1974 was 8.8% of GNP); some energy resources are depletable, not only in an ultimate sense, but, for the U.S., in the more pressing sense that "known" oil and gas reserves are only 10.3 and 11.1 times annual production respectively; there are significant uncertainties about total resources available and about technologies; the United States is significantly dependent on other countries for petroleum; time lags in the adjustment of the system to changes in supply and demand conditions are substantial; energy demand and supply are price responsive; parts of the energy system are subject to governmental regulation; there are regional differences in the availability of energy within the U.S., and there are large interregional energy flows; energy is an intermediate good. Thus, in the long run there would not be significant differences among the costs per effective BTU of energy supplied from different energy sources.

41631 **Consequences of the energy crisis.** Andrzejewski, S. *Przegl. Elektrotech.;* **52**: No. 1, 1-5(Jan 1976). (In Polish).

The manifold increase of liquid fuel prices and the subsequent considerable increase of solid fuel prices has attracted attention to the fact that the economically developed countries depend on the import of fuels. The low cost of liquid fuels, up to 1973, resulted in substantial decrease in coal output and development of dual-purpose heat and electric power stations. At present, developed countries are striving to make themselves independent of excessive fuel imports. Above all, the nuclear power industry is developing, both for electricity and heat supplies. The use of high-temperature reactors in chemical processing of coal and in metallurgy is discussed. Good results achieved in operation of prototype breeder reactors justify the assumption that power stations using these types of reactors will soon increase the utilization of uranium and reduce the demand for enriched uranium.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 40861, 41587, 41597

41632 (AD-A—034611) **Report to Congress by the Federal Aviation Administration on the energy efficiency of agency regulations. Final report.** (Federal Aviation Administration, Washington, D.C. (USA)). Nov 1976. 133p. NTIS, PC A07/MF A01.

See also report dated Apr 1976, AD-A—023765.

All regulations and laws administered by the FAA were examined for their effect on energy consumption. An inventory of regulations requiring activities which lead to fuel usage was prepared and organized. The following general groupings were identified: (1) Flight Test Programs; (2) Environmental Control; (3) Aircraft Fuel Supply; (4) Aircraft Speed and Flight Altitude; (5) Airspace and Air Traffic Control; (6) Aircraft Equipment; (7) and Crewmember Qualifications.

41633 (NSF-RA—760006, pp 243-246) **Strategies for legislative change.** Hamburger, R. 14 Jul 1976.

From Conference on alternatives in energy conservation: the use of earth covered buildings; Fort Worth, TX, USA (9 Jul 1975).

In Alternatives in energy conservation: the use of earth covered buildings.

The author reviews public policy changes related to energy conservation that would encourage more use of earth-covered buildings; more specifically the public policy changes which could be enunciated by legislative changes. Others have explored specific legislative changes such as tax incentives, zoning, public assistance, etc. This review discusses how one might go about getting these changes implemented. There are at least two assumptions which are made in this discussion. The first assumption that earth-covered structures will provide a net conservation of energy. Stated another way it is assumed that the extra energy which may be required to construct the earth-covered structure will be more than offset by a reduction in the use of energy during the structures operating life plus the savings in not having to use certain materials (insulation, etc.) which require energy in their manufacture, transportation to the site, and installation. The second assumption is that for certain purposes, earth-covered buildings are the best approach for conserving energy and at least as effective as other approaches for the basic use for which they are being designed. With these assumptions the question is how to get legislators to take such action as required in the public interest (and to conserve energy) so as to encourage the greater use of subsurface space. Though the first step is to recognize the realities the legislator faces, this is the last step in the process. The first step in the process is to identify the need (in this case the conservation of energy by building earth-covered structures). The second step is to find an owner who perceives a financial advantage to having such a building. The third step is to find financing. Without all three of these steps, it is useless to seek legislative changes since without the need and the demand there is no reason for the legislation. (MCW)

41634 (PB—255319) **Mandatory Canadian crude oil allocation regulations. Environmental impact statement (final).** (Federal Energy Administration, Washington, D.C. (USA)). May 1976. 375p. (FEA/H—76/220;FES—76/1). NTIS $10.50.

On January 30, 1976 the Federal Energy Administration (FEA) promulgated regulations to allocate diminishing amounts of Canadian crude oil deliveries during the period of 1976 through 1981, the last year in which some amount of Canadian crude would be made available. The Regulations reflect FEA's action to minimize the impact of the Canadian action. (GRA)

41635 **Long-run model for energy policy analysis.** Hnyilicza, E. (Massachusetts Inst. of Tech., Cambridge). pp 758-763 of In Proceedings of the 1976 summer computer simulation conference. La Jolla, CA; Simulation Councils, Inc. (1976).

From Summer computer simulation conference; Washington, District of Columbia, United States of America (USA) (12 Jul 1976).

See CONF-760703—.

The theoretical foundations and empirical specifications of a policy-oriented macroeconometric energy model designed to capture the long-run dynamic interactions between the U.S. energy sector and the aggregate determinants of economic growth are discussed. The major distinguishing features of this model are the following: it treats the energy sector as an integral part of the national economy and consequently allows the examination of the interactions between the conditions of the energy markets and the configuration of national output; its theoretical basis lies in the neoclassical theory of general equilibrium. This implies that the prices and quantities of all goods and factors transacted within a given period are determined within a simultaneous process of market equilibration; and it is a policy-oriented model, incorporating explicit policy variables such as tax rates on capital income and capital property, sales and excise taxes on consumption and investment goods, investment tax credits, taxes on labor income, etc. The model permits the evaluation of any combination of policy variables as to their joint effect on the energy requirements of the economy, both through incentives for additional supply or incentives for decreased energy consumption. In addition, the effectiveness of policy options such as import tariffs or import quotas can also be evaluated in terms of their effect on the long-term energy self-sufficiency of the nation.

41636 "North Carolina Energy Policy Council" Annual report. Volume I. Raleigh, NC; North Carolina Energy Policy Council (1977). vp. (NP—21753/1). Dept. of Commerce, Raleigh, NC.

The Act creating the North Carolina Energy Policy Council basically requires the Council to assess the energy situation as it affects the State and to make appropriate policy recommendations for consideration by the Governor and the General Assembly. The record of the activities of the first Council is presented in a report published in two volumes. Volume I contains an executive summary, an overview of the Council's activities and chapters describing the work of each of the four subcommittees formed to work in the principal energy areas of management, conservation, emergency planning, and research and development. Also included are appropriate recommendations, resolutions passed, and descriptions of proposed plans or programs prepared by the Council.

41637 "North Carolina Energy Policy Council" Annual report. Volume II. Raleigh, NC; North Carolina Energy Policy Council (1977). vp. (NP—21753/2). Dept. of Commerce, Raleigh, NC.

Volume II is a companion to Volume I and has been published on a limited basis as a working document. This volume includes the four energy plans which are the basis for the development of a comprehensive long-range State energy policy. The sequence of the State energy plans is: Energy Management Plan, Energy Conservation Plan, Energy Emergency Plan, and Energy Research and Development Plan.

FOSSIL FUELS

41638 Economic analysis of environment and energy in the petroleum refining, electric power, and chemical industries. Thompson, R.G.; Lievano, R.J.; Calloway, J.A. (Univ. of Houston, TX). pp 788-794 of In Proceedings of the 1976 summer computer simulation conference. La Jolla, CA; Simulation Councils, Inc. (1976).

From Summer computer simulation conference; Washington, District of Columbia, United States of America (USA) (12 Jul 1976).

See CONF-760703—.

The primary purpose of this study is to show how the regulated vs. the competitive use of fuel oil and natural gas in electricity generation will affect the market-clearing prices of natural gas, the end use of important energy products, and the production costs of heavy industry in 1985. Solutions are computed for different supply responses to price to show the effects of uncertainties in forecasting supplies of domestic petroleum. Results of the modeling study show the following: (1) prohibition of petroleum fuel use in new electric power generation facilities significantly moderated the economic costs of attaining clean water and clean air; this policy action forces the electric utilities to substitute investments in coal-using and emission-control facilities for scarce clean fuels; and (2) large uncertainties in future indigenous supplies of crude oil and natural gas in the United States did not change the character of the modeling results described above.

41639 Alternative liquid fuels and the ERDA program. Lanning, W.C.; Thompson, C.J. (Bartlesville Energy Res Cent, Okla). *Am. Soc. Mech. Eng., [Pap.]*; No. 76-Pet-15, 1-8(Sep 1976).

An overview of selected fossil fuel aspects of government programs of energy R and D is given, dealing principally with crude oils from coal and oil shale as feedstocks for production of refined liquid fuels. The importance of these fuels to the overall supply of energy for the remainder of this century and beyond is brought out. The crucial problems of refining synthetic crude oils are the removal of nitrogen as a major impurity and the conversion of heavy ends in the highly aromatic liquids from coal. Composition and general character of feedstocks and refined products are summarized. Finally, the selection of the most suitable coal feedstocks, more economical liquefaction and refining processes, and use of broadcut distillate fuel in new automotive engines are discussed as potentially important future developments. 18 refs.

COAL

REFER ALSO TO CITATION(S) 40730, 40852, 40859, 40860, 40861

41640 (PB—255855) **Implementing coal utilization provisions of Energy Supply and Environmental Coordination Act.** (Federal Energy Administration, Washington, D.C. (USA). Office of Energy Resource Development). Apr 1976. 42p. (FEA/G—76/193). NTIS $4.00.

SEe also report dated Apr 75, PB—250104.

This report reviews the status and current strategy of FEA's program for implementing the coal utilization provisions of the Energy Supply and Environmental Coordination Act of 1974 (ESECA) (P.L. 93-319) as amended by the Energy Policy and Conservation Act (EPCA) (P.L. 94-163). (GRA)

41641 (PB—258636) **The potential of coal as a commodity to be traded on United States commodity exchanges. Preliminary evaluation.** (Marcom, Inc., Great Neck, N.Y. (USA)). 4 Apr 1976. Contract FEA-P-05-75-6769-0. 20p. NTIS $3.50.

This report examines the pattern for pricing and selling coal through individual negotiation which has existed for many years. One of the basic questions examined is whether this method of doing business is applicable in view of the aggressive production plans which are now national policy. In addition, this marketing method is examined in terms of whether it serves the best interests of the various economic interests involved in the coal industry. Further, the report examines the questions relating to the possibilities of coal being traded as a commodity on one or more exchanges. The potential impacts on various economic interests for coal are discussed. The report includes a review of the shortcomings inherent in the present selling pattern, recommendation for changes to improve business and suggested steps to implement such recommendations. (GRA)

41642 Strip mining in the corn belt: the destruction of high capability agricultural land for strip-minable coal in Illinois. Doyle, J.C. Jr. Washington, DC; Environmental Policy Institute (1976). 36p. (NP—21750).

The State of Illinois, with over 81 percent of its total land surface classified as farmland, has some of the richest agricultural land in the world. Illinois also has one of the largest reserves of bituminous coal in the United States east of the Mississippi River—over 160 billion tons. Strip-minable coal comprises about 12.1 percent of the state's total coal reserve, but is found in 51 counties, many of which have highly productive agricultural soils. It is known that mining these reserves via stripping methods will directly disturb some 2.5 million acres in at least 40 of these counties. There is presently no demonstrated evidence that can guarantee that productive agricultural lands strip-mined for coal will be fully restored to their pre-mining agricultural capability. Deep-minable reserves comprise the bulk of the state's total reserve and are found concentrated in 14 counties, accounting for 40 percent of all Illinois coal. At stake is the long-term viability of agricultural communities throughout the state, the importance of Illinois agriculture as a leading supplier of foodstuffs to the nation and the world, and the contribution of Illinois agriculture to the nation's balance of payments. So long as there are deep-minable coal reserves available in the quantities found in Illinois, there is no need to gamble away long-term productive agricultural capacity at the hand of short-term strip-mining economies. The Surface Mining Control and Reclamation Act now pending before the U.S. Congress contains a procedure for designating areas unsuitable for strip mining that would offer a public review process and possible protection for those highly productive agricultural lands now threatened by strip mining. (MCW)

PETROLEUM

REFER ALSO TO CITATION(S) 40917, 40930, 40932, 40990

41643 (PB—255992) **Crude supply alternatives for the northern tier states. Volume I. Executive summary.** (Bonner and Moore Associates, Inc., Houston, Tex. (USA)). 24 Jul 1976. Contract FEA-CR-05-60593-00. 42p. (RAH—070A). NTIS $4.00.

See also Volume 2, PB—255993.

This executive summary presents major conclusions drawn from an analysis of various alternatives for supply of crude oil and petroleum products to the Northern Tier States. (GRA)

41644 (PB—255993) **Crude supply alternatives for the northern tier states. Volume II. Technical report.** (Bonner and Moore Asso-

ciates, Inc., Houston, Tex. (USA)). 25 Jul 1976. Contract FEA-CR-05-60593-00. 447p. (RAH—070). NTIS $11.75.

See also Volume 1, PB—255992.

Feasibility, cost, and potential impacts of various alternate crude oil supply sources and transportation systems for the Northern Tier area are discussed. Of particular importance are the environmental and socio-economic impacts, as well as political and legal considerations. Because of the projected surplus of Alaskan North Slope crude and in view of its potential as a secure source, economic and price implications are examined. (GRA)

41645 Middle East oil. New York; Exxon Corporation (1976). 32p. (NP—21779).

Crude oil reserves are the most impressive measure of the importance of the Middle East. Recent published estimates put the region's proved reserves at about 400 billion barrels (60 percent of the world total) and its productive capacity at nearly half the world total. It is this very fact of great oil productive capacity, based on vast proved reserves plus the probability of huge undiscovered potential, which gives the Middle East region a pre-eminent position in any forecast of future oil supplies. A history of operations in Iran, Iraq, Bahrain, Kuwait, Saudi Arabia, the Kuwait-Saudi Arabia Neutral Zone, Qatar, Abu Dhabi, Libya, Egypt, Oman, Dubai, and Sharjah is presented. The birth of OPEC in 1960 and the 1973 embargo and subsequent price increases are reviewed; the effects of the latter are analyzed briefly. Ten charts, six tables, and a map are included. (MCW)

41646 List of Louisiana oil and gas fields and salt domes including the offshore areas showing code numbers and official abbreviations. Stanfield, C.P. (comp.). Baton Rouge, LA; Department of Conservation (1976). 142p. (NP—21744).

This publication is intended specifically for industry personnel responsible for unit nomenclature on plats and Department of Conservation reports. All oil and gas fields discovered prior to September 1, 1968 were assigned an official abbreviation which shall be used when the respective field name is necessary for proper unit nomenclature purposes. The official abbreviation is now assigned simultaneously with the new field name and is available from various sources. The following information is also included: Introduction and Notice of Amendment to Statewide Order No. 29-B; Procedure for Filing of Exhibits and Unit Nomenclature; Procedure for Assigning Nomenclatures, Coding, Allowables, and Filing of Reports for all Types of Units; Notice on Sand Name Abbreviations; List of Sand Name Abbreviations, showing the Preferred Abbreviation as the first listed; Abbreviations used within the List of Field Names; List of Louisiana Parishes and their Code Numbers; List of Districts and their Area Codes; List of Code Numbers for Various (Commingled) Wells and for Wildcat Wells in their Respective Districts; List of Field Names, showing Discovery Date, Field Abbreviation, Field Code, Producing Salt Domes, Township and Range, Parish, Production, District and Area Code, and also Secondary Recovery and Pressure Maintenance Operations; Inactive Fields used in Cumulative Production Volumes; List of Non-Producing Onshore Salt Domes; Changes in Field Names that have been made through the years; and Alphabetical List of Abbreviations of all field names, for use in determining and assigning new abbreviations for new fields. (MCW)

41647 Production statistics and engineering data: oil in North Dakota, second half 1976. Grand Forks, ND; North Dakota Geological Survey (1976). 280p. (NP—21740). $3.50.

This report includes production statistics and engineering data on the oil and gas pools in the State of North Dakota for the second half of 1975. The information has been taken from the official files of the State Industrial Commission and the North Dakota Geological Survey, and reflects the information submitted by the operators. Although similar information is available from commercial sources, this report represents the OFFICIAL publication of this data. The data tabulated for each of the approximately 150 pools in North Dakota are: location; spacing; discovery date; discovery well; production formation; datum; deepest test; oil wells; production data; accumulative production data to January 1, 1976; reservoir data; oil production; and water production; and pool total. (MCW)

NATURAL GAS

REFER ALSO TO CITATION(S) 41646, 41647, 41653

HYDROGEN AND SYNTHETIC FUELS

REFER ALSO TO CITATION(S) 41161

ELECTRIC POWER

41648 (EEI—76-85) Report on equipment availability for the ten-year period, 1966—1975. (Edison Electric Inst., New York (USA)). Dec 1976. 63p. Edison Electric Inst., New York, NY.

This is an annual report of availability and outage statistics for electric power generating facilities operating in the United States. A list of utility organizations voluntarily participating in the EEI Equipment Availability Program in 1975 is located in Appendix F. All summary reports in this publication are for the 10-year period 1966-1975. Each reporting utility company has received reports on individual units for which data were submitted. Also, selected major equipment manufacturers receive copies of computer reports showing an analysis of the data for their equipment. Revised reporting instructions to incorporate Safety and Environmental Requirement Cause Codes were issued effective January 1, 1976. In addition, provisions were made for identifying major equipment manufactured outside of the United States or under foreign license. Recognizing that an Annual Report contains only a limited amount of general outage data in selected categories, the Task Force has agreed to perform special analyses of the data bank if the cost of computer services is met by the requestor and if the required analysis conforms to some designated policy guidelines.

41649 (PB—254307) Economic and financial impacts of federal air and water pollution controls on the electric utility industry. Executive summary. Final report. (Temple, Barker and Sloane, Inc., Wellesley Hills, Mass. (USA)). May 1976. Contract EPA-68-01-2803. 44p. NTIS $4.00.

See also PB—254308.

This report is the result of a major program of studies sponsored by the Environmental Protection Agency as part of its continuing effort to assess the economic impacts of its regulatory programs. It examines the combined effect of all of EPA's direct regulatory programs on the electric utility industry. The study focused on the determination of changes in the financial profile of the electric utility industry which are likely to result from federal air and water pollution controls for the 1975-1990 period.

41650 (PB—254774) Assessing the potential for optimal utilization of off-peak power. Volume I. Executive summary. Final report. Walukas, D.J. (Westinghouse Research Labs., Pittsburgh, Pa. (USA)). 29 Dec 1975. Contract DI-14-01-0001-1892. 16p. NTIS $3.50.

A one-year four-task study and demonstration for assessing the potential for optimal utilization of off-peak power are described.

41651 (PB—254775) Assessing the potential for optimal utilization of off-peak power. Volume II. Electrical loads offering major potential for the use of off-peak power. Final report. Walukas, D.J. (Westinghouse Research Labs., Pittsburgh, Pa. (USA)). 29 Dec 1975. Contract DI-14-01-0001-1892. 721p. NTIS $18.75.

Tasks 1 and 2 of a one-year study and demonstration for assessing the potential for optimal utilization of off-peak power are described. Three subtasks were performed in the completion of Task 1: (1) study all of the major end uses of electric power, (2) determine the major potential uses of off-peak power, and (3) describe historical patterns of operation and make future projections. The effort in Task 2 was divided into three subtasks: (1) Analyze potential off-peak power use option for: (a) economic considerations to the utility, builder or manufacturer, and uses, (b) design characteristics, including safety, comfort, bulk/weight, and esthetics, (c) effects on the environment, (d) implementation problems and solutions, (e) research and long-term development required for implementation, and (f) economic, employment, and social costs and benefits; (2) describe the energy conservation potential of each off-peak power use option; and (3) determine the off-peak power use option best suited for a pilot demonstration.

ELECTRIC POWER GENERATION

REFER ALSO TO CITATION(S) 41613

41652 (PB—254308) Economic and financial impacts of federal air and water pollution controls on the electric utility industry. Final technical report. (Temple, Barker and Sloane, Inc., Wellesley Hills, Mass. (USA)). May 1976. Contract EPA-68-01-2803. 515p. NTIS $12.75.

See also PB—254307.

Changes in the financial profile of the electric utility industry which are likely to result from federal air and water pollution controls for the 1975-1990 period are discussed. The analysis provides operating and financial projections at the national and regional levels as well as a detailed discussion of the financing needs and problems of the industry in the context of trends and cycles in corporate business financing. In addition, the study includes an analysis of the secondary impacts of the legislation on major industrial users of electricity. (GRA)

41653 **Changes in an electric utility's fuel base.** Kralik, W.A. pp 251-259 of In 23rd annual conference of the Institute of Electrical and Electronics Engineers. New York; Inst. of Electrical and Electronics Engineers (1976).

From 23. annual conference of the Institute of Electrical and Electronics Engineers; Philadelphia, PA, USA (30 Aug 1976).

The conditions which require an electric utility to change from an operation which uses natural gas as a boiler fuel to one adding other forms of fuel for base load generation are discussed. The problems of making that change with today's financial and governmental requirements are also discussed. The relationship between utilities and the petroleum industry is considered in light of the fuel supply problem. Actual experiences of Central Power and Light Company, an electric utility located in South Texas, serves to illustrate the main points of this discussion.

CONSUMPTION AND UTILIZATION

REFER ALSO TO CITATION(S) 41605, 41606, 41612, 41616, 41632

41654 (ORAU/IEA(M)—77-6) **Energy embodied in goods.** Reister, D.B. (Institute for Energy Analysis, Oak Ridge, Tenn. (USA)). Feb 1977. Contract EY-76-C-05-0033. 20p. Dep. NTIS, PC A02/MF A01.

This paper describes why the use of cost estimates can be a source of uncertainty in net energy analysis. This occurs when costs are expressed in prices not equal to those used for price deflators. This uncertainty is reduced by estimating average prices for selected goods and services in units of 1967 dollars per ton. When multiplied by energy intensity coefficients, one obtains the energy embodied in 367 different goods in units of Btu per 1967 dollar and, with prices, one can convert these coefficients into units of Btu per ton. This paper also defines the "atypical product" problem and shows that by using energy intensity coefficients measured in Btu per ton, one obtains more accurate results than by using coefficients measured in Btu per 1967 dollar. (auth)

41655 (PB—255946) **Private individual's willingness to make energy-saving efforts and their perception of the likelihood of others doing the same. Highlight report, Volume XIX.** (Opinion Research Corp., Princeton, N.J. (USA)). Feb 1976. Contract FEA-CO-04-50236-00. 26p. NTIS $4.00.

The report given addresses: (1) individual predispositions toward energy saving behavior, (2) the importance of energy saving, and (3) likelihood of other people conserving energy. It was found that past behavior is generally regarded as the most accurate predictor of future behavior patterns.

UNCONVENTIONAL SOURCES AND POWER GENERATION

SOLAR

REFER ALSO TO CITATION(S) 41180, 41200

41656 (DSE/115—1) **Solar energy in America's future: a preliminary assessment.** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Solar Energy). Mar 1977. 126p. Dep. NTIS, PC A07/MF A01.

The report documents a Stanford Research Institute study of the potential roles that solar energy technologies could have for meeting U.S. energy needs over the next 45 years. Computer simulations of different energy supply projections were developed by varying the input parameters of energy demand and energy costs. Three of these projections were chosen to be developed into broader scenarios—that is, richer scripts of the future. First, the implementation measures required to realize these scenarios were delineated. Then, the economic, socio-economic, socio-political, and environmental issues associated with different energy futures were identified, and these issues were compared among the three scenarios. Finally, six major societal issues were synthesized from an analysis of the scenarios. These issues and the three scenarios were evaluated from the perspectives of individuals in different perceptual frames-of-reference.

41657 **Solar energy: one way to citizen control.** Fritsch, A.J. (ed.). Washington, DC; Center for Science in the Public Interest (1976). 128p. (NP—21741). $8.00.

This report presents a case for the localized and decentralized use of solar energy. It discusses solar technologies, analyzes government programs for developing solar energy, and presents a philosophy of local citizen control of energy resources. Although the southern parts of the U.S. receive more solar radiation than the northern sections, all parts of the country are bathed in enormous amounts of solar energy. Successful solar buildings in New England have proven solar energy is viable all over the nation. Residential solar space heating is cheaper than electric-resistance heating in all parts of the country and is competitive with natural-gas heating in most of the country, according to this report. Rising competitive fuel prices will further enhance the viability of solar heating, as will coming developments in thermal storage technology. It is felt that, with proper development, solar electricity can become economically competitive with conventionally generated electricity in five to ten years. Solar electricity units can be integrated into "total energy systems" which supply both heat and electricity. Solar total energy promises to be versatile, flexible, highly efficient, and economical. Sometime in the future, hydrogen produced from solar energy and water may become a prominent source of energy. The qualities of both solar energy and solar technologies suggest that solar energy is best harnessed in small, decentralized applications. Ownership of solar energy equipment can turn the citizen and the community into an energy producer instead of just an energy consumer. Local community development of solar energy can bring control of the energy supply away from the giant energy industries and back to the citizens.

OTHER

REFER ALSO TO CITATION(S) 41166

ENERGY CONVERSION

MHD GENERATORS

DESIGN AND DEVELOPMENT

41658 (AD-A—028323) **Pulsed magnetohydrodynamic program. Final report 2 Jan 72—31 Mar 76.** Bangerter, C.D.; Hopkins, B.D.; Brogan, T.R. (Hercules, Inc., Magna, Utah (USA). Bacchus Works). 16 Jul 1976. Contract F33615-72-C-1394. 259p. NTIS $9.00.

See also report dated May 73, AD—762934.

The goals of the program were twofold: (1) To develop the technical base to allow for the design and construction of lightweight, multimegawatt deflagrating solid explosive driven MHD (C-MHD) and, (2) to evaluate the feasibility of multikilowatt, high-repetition-rate detonating solid explosive MHD (X-MHD) generators. The report is divided into two sections which are organized in a roughly parallel format. Part I covers the work on deflagrating explosive MHD while Part II covers detonating explosive MHD. Each part has an introduction, a description of the experimental apparatus, the test results, conclusions and recommendations for future development. In addition, part 1 has a section covering the selection of a solid propellant while part 2 has a separate section with some additional discussion of the X-MHD channel performance.

41659 (FE—1760-26) **Development program for MHD direct coal-fired power generation test facility. Quarterly technical progress report, July—September 1976.** Dicks, J.B.; Tempelmeyer, K.E.; Wu, Y.C.L. (Tennessee Univ., Tullahoma (USA). Space Inst.). 15 Oct 1976. Contract EX-76-C-01-1760. 48p. Dep. NTIS $4.00.

The activity carried out under Task I during this quarter consisted primarily of (1) completion of diffuser test analysis, and (2) experimental evaluation of a slag/seed separation and seed recovery process. The first series of these latter tests was completed, but the test sample analysis is not yet finished. Prototype collection equipment to recover the potassium sulfate seed material leaving the slag/seed separation cyclone were delivered to UTSI. A testing program to evaluate (1) a high energy venturi scrubber and (2) a baghouse as a means of collecting particulate K_2SO_4 was developed. Under Task II approval of the final design for the site development, office/lab building, and roads and utilities was received from ERDA. Bids are being solicited for this first-phase construction. The bid opening will be October 7, 1976. In addition, the preliminary design package for the complete coal-handling and processing system was forwarded to ERDA for review. This package included (1) a design review report, (2) preliminary system and process drawings, (3) detailed drawings of the various components, (4) a listing of all off-the-shelf equipment used in this system, and (5) cost estimates. Work on the second phase construction package which will include the test building and control room and all foundation slabs and supports for the remainder of the facility continued. Work on slag/seed deposition is continuing under Task IV. Tests have been completed in which a combination of coal and kerosene were employed as the fuel to simulate the condition of moderate ash carryover. A significant effort was also expended under this task to prepare for the future testing of a variety of Soviet materials and materials from the National Bureau of Standards which will be evaluated in a coal-fired environment and in Leg II at UTSI.

41660 (N—76-25019) **Research program in magnetogasdynamics utilizing hypervelocity coaxial plasma generators. Final report.** Spight, C. (New Technology, Inc., Huntsville, Ala. (USA)). 31 May 1976. 11p. (NASA-CR—147961). NTIS $3.50.

A broadly-gauged research program in magnetogasdynamics utilizing hypervelocity coaxial plasma generators is presented. A complete hypervelocity coaxial plasma generator facility was assembled and tested. Significant progress was made in the direction of understanding the important processes in the interaction of hypervelocity MGD flow with transverse applied fields. It is now proposed to utilize the accumulated experimental capability and theoretical analysis in application to the analysis and design parameterization of pulsed magnetogasdynamic direct energy convertor configurations.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 40849

DUCT ENGINEERING AND FLUID DYNAMICS

41661 **Electrical engineering characteristics of MHD generators operating by emulsion.** Hansen, J.P. (Lab Cent des Ind Electr, Fontenay-aux-Roses, Fr). *Rev. E;* **8**: No. 2, 33-44(1975). (In French).

The conditions under which MHD generators with a liquid-metal flow can be usefully associated with nuclear power generating units are reviewed. Experiments performed on a water-air model of a two-phase flow that could be used in an emulsion-type generator are described. In such a generator a gas or vapor, describing a thermodynamic cycle, imparts a motion to the liquid metal through the production of an emulsion between the gaseous and liquid phases. An electrical-engineering model of this type of converter is derived, in order to compare the emulsion generator with conventional liquid-metal MHD generators.

THERMOELECTRIC GENERATORS

REFER ALSO TO CITATION(S) 41157

THERMIONIC CONVERTERS

DESIGN AND DEVELOPMENT

41662 **Thermionic conversion.** Thring, M.W. (Int Flame Res Found). *Chart. Mech. Eng.;* **22**: No. 7, 75-77(Jul 1975).

The principles of thermionic conversion which, like a thermopile, enables heat flowing from a high-temperature source to a heat sink to be converted into dc electric power are discussed. Less than theoretical quantities of electricity are obtained due to factors analogous to the internal resistance of an electric cell. This can be minimized by having electrodes very close together--in the order of 10μ. Very accurate alignment under high-current output is to create positive ions within the space to neutralise the charge. Examples are proposed for the use of thermionic conversion power sources for space modules in which heat is provided by the focused rays of the sun, and in nuclear reactors. In this latter application it is proposed that thermionic converters should surround the fuel element so that some of the heat energy is converted directly into electricity. 2 refs.

FUEL CELLS

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 41663

MATERIALS, COMPONENTS, AND AUXILIARIES

41663 (AD-A—034454) **Research on electrochemical energy conversion systems. Final technical report, 1 Jul 1975—30 Jun 1976.** Adams, A.A.; Foley, R.T. (American Univ., Washington, D.C.). Jul 1976. Contract DAAG53-76-C-0001. 33p. NTIS, PC A03/MF A01.

The project on electrochemical energy conversion system has involved two tasks: the determination of the electrochemical behavior of low molecular weight hydrocarbons and alcohols as well as other possible fuels in aqueous trifluoromethanesulfonic acid and the examination of the electro-chemical interaction of fuel cell reactants with platinum surfaces in aqueous trifluoromethanesulfonic acid. The order of reactivity for low molecular weight alkanes was determined to be C_3H_8 greater than C_2H_6 greater than n-C_4H_{10} greater than CH_4 in trifluoromethanesulfonic acid monohydrate. The same reaction order had been established previously for low molecular weight alkanes in inorganic acids such as HF, H_2SO_4, and H_3PO_4. In the case of each alkane the electrochemical activity in the sulfonic acid was significantly greater than that in phosphoric acid under the same conditions. The electrooxidation of each alkane was evaluated over the temperature range from 95 C to 135 C. The experimental data collected during this reporting period confirm the previous finding that trifluoromethanesulfonic acid monohydrate represents an improved electrolyte for the hydrocarbon-air fuel cell.

41664 (N—76-24724) **Investigation of acid-resistant electrocatalysts for fuel cells.** Meier, H.U.; Tschirwitz, U.; Zimmerhackl, E.; Albrecht, W. (Staatliches Forschungsinstitut fuer Geochemie, Bamberg (Germany, F.R.)). 1975. 104p. (BMVG-FBWT—75-6). NTIS $5.50.

Sponsored by Bundesmin. Der Verteidigung.

Methods used in the synthesis of electrocatalysts belonging to the class of polymeric metal-phthalocyanines and the procedure of testing electrocatalytic properties of these polymers are reported. Various properties of polymeric phthalocyanines (such as conductivity, catalase effect, and stability in acid) and the electrocatalytic activity for the reduction of oxygen obtained in sulfuric acid are described. A high catalytic activity with respect to the oxygen reduction was obtained in 6 n H_2SO_4 with carbon-Teflon electrodes containing polymeric iron-phthalocyanine compounds. The current density was 20 to 80 mA/sq cm for a potential of 850 to 650 mV (standard hydrogen electrode) at room temperature. The potentials of the electrodes with polymeric phthalocyanine complexes of iron (and cobalt) as catalysts show only a relatively small decrease with time which is in the order of less than 100 mV at a load of 20 mA/sq cm during 1,000 hr. The high electrocatalytic activity of Fe-polyphthalocyanines is explained using a model.

41665 (N—76-28340) **Space shuttle engineering and operations support. Orbiter to spacelab electrical power interface. Avionics system engineering.** Emmons, T.E. (McDonnell Douglas Astronautics Co., Houston, Tex. (USA)). 30 Jun 1976. Contract NAS9-14960. 29p. (NASA-CR—147834;REPT—1.3-DN-C0504-036). NTIS $4.00.

The results are presented of an investigation of the factors which affect the determination of Spacelab (S/L) minimum interface main dc voltage and available power from the orbiter. The dedicated fuel cell mode of powering the S/L is examined along with the minimum S/L interface voltage and available power using the predicted fuel cell power plant performance curves. The values obtained are slightly lower than current estimates and represent a more marginal operating condition than previously estimated.

BRAYTON

REFER ALSO TO CITATION(S) 41157

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

REFER ALSO TO CITATION(S) 41625

41666 (NTIS/PS—77/0042) **Time series forecasting and prediction (a bibliography with abstracts). Report for 1964—Jan 1977.** Grooms, D.W. (National Technical Information Service, Springfield, Va. (USA)). Feb 1977. 147p. NTIS, PC N01/MF A01.

Supersedes NTIS/PS—76/0031 and NTIS/PS—75/150.

Studies on the use of time series analysis in predicting and forecasting various events are presented. The bibliography includes applications to hydrology, population growth, pollution, motor vehicle accidents, meteorology, criminal investigations, management, and energy consumption. (This updated bibliography contains 142 abstracts, 25 of which are new entries to the previous edition.)

41667 **Consultant's approach to total energy.** Sutton, K.W. (Dale and Ewbank, London, Engl). *Electron. Power;* **21**: No. 10, 614-618(29 May 1975).

The possible use of total-energy systems as a means of reducing overall energy consumption of commercial and industrial users is considered. Some of the considerations involved when initiating an analysis of a total-energy system are discussed.

BUILDINGS

REFER ALSO TO CITATION(S) 41585, 41588, 41589, 41591, 41592, 41593, 41594, 41595, 41596, 41609, 41611, 41612, 41633, 41657, 41689

41668 (N—76-28511) **Criteria for underground heat distribution systems.** (National Academy of Sciences - National Research Council, Washington, D.C. (USA). Standing Committee on Mechanical Engineering). 1975. Contract NASW-2461. 87p. (NASA-CR—148514). NTIS $5.00.

A new scheme for turbulence simulation for mixed convection flows is proposed noting the inadequacy of the usual coupled differential equations to take into account the transitions from laminate to turbulent flow and the setup of equilibrium regimes. In the new scheme only the energy equation is kept and the turbulence scale is determined from the convection and the qualification of the environment of the point being considered in the calculation. An approximation of the modifications needed to take into account the gravity forces caused by density differences is proposed together with a few worked out examples.

41669 Generator boilers. *Heat. Air Cond. J.;* **44**: No. 524, 32-39(1975).

A versatile range of Swedish steam and hot water boilers described has been introduced into the United Kingdom, based on the Corner Tube principle and designed to burn oil, gas, solid or waste fuel as required, and are reported to be particularly suitable for district heating applications. The basic design consists of an all-welded cage system of corner tubes with interconnecting longitudinal and transverse headers and welded-in heating surfaces such as furnace walls and convection heating banks.

41670 Liquid coupled system for heat recovery from exhaust gases. Strindehag, O. *Build. Serv. Eng.;* **43**: 52-56(Jun 1975).

The basic equations for the technical optimization are given, and a computer program is described which gives the optimum liquid flow, the temperature efficiency and the pressure drops for three sizes of supply and exhaust air heat exchangers. Also described is a sub-program, which can be used for calculation of the energy saving per year for different system efficiencies. The procedure for figuring out the profitability of the various alternatives is discussed.

41671 Function and evaluation of air-conditioned luminaires--2. Hilbert, G.S. (Stift Preuss Kulturbesitz, Berlin, Ger). *Lichttechnik;* **28**: No. 9, 377-382(Sep 1976). (In German).

Ventilated luminaires, extraction luminaires and similar systems should not to be called air-conditioning luminaires unless they emit the luminous flux of the lamp(s) in the useful area with a high degree of optical efficiency (operating efficiency), unless they largely reduce the radiant flux outside the visible range, and unless they permit the radiant energy absorbed in the luminaire to be dissipated as convected heat. The ratio of optical efficiency eta/sub L/ and eta/sub LB/ to radiation efficiency eta/sub eL/ is defined as the assessment factor kappa. Inadequately ventilated luminaires supply values of kappa<1, whereas air-conditioning luminaires provide values of kappa<1.

41672 Controlled heat from the floor. Electric floor heating accumulates heat in the concrete floor. Roenisch, J. *VDI (Ver. Dtsch. Ing.) Nachr.;* **30**: No. 40, 14(Oct 1976). (In German).

3 figs.

At present, about 7 % of the new buildings are designed to have the rooms electrically heated. A report is given on the feasibility of electrical floor heating. A satisfactory comfort in the rooms is achieved with this low-temperature radiator heating. It is thus possible to reduce the room temperature by about 2 to 3°C compared to common heating which corresponds to a saving of 8 to 12% heating costs. The floor heating takes place at the cheap night-rate. It is possible, where necessary, to briefly heat an additional heating circuit which is placed close to the outer wall region separately from the main heating system.

RESIDENTIAL

REFER ALSO TO CITATION(S) 41655

41673 (PB—255652) **Evaluation of the air-to-air heat pump for residential space conditioning. Final report.** (Gordian Associates, Inc., New York (USA)). 23 Apr 1976. Contract FEA-CO-04-50171-00. 293p. NTIS $9.25.

The objective of the study described was to evaluate the (a) reliability, (b) market acceptance and (c) energy effectiveness (in comparison to electric resistance and fossil fuel space heating systems) of the electric heat pump for residential space heating. An additional objective was to evaluate the impact of increased heat pump saturation on the nation's primary fuel reserves and to develop justified policy options for the Government toward this form of space heating. The approach adopted in the study, as established by the requirements of the contract, was (a) to critically evaluate available sources of technical information on heat pump performance and market applicability, (b) to make inquiries of selected electric utilities heat pump manufacturers and heating and air-conditioning contractors, and (c) to compare by computer simulation the energy effectiveness of the heat pump versus electric resistance and fossil fuel space heating systems for representative climatological regions of the continental United States.

41674 (PB—255655) **Incentives for energy conservation in multifamily housing.** (Real Estate Research Corp., Washington, D.C. (USA)). Nov 1975. Contract FEA-CO-04-50226-00. 196p. NTIS $7.50.

The report given discusses market characteristics of multifamily housing, types of actions that can be undertaken to improve energy conservation in multifamily units, incentives and disincentives that influence conservation actions, and the probable impact of such incentives and disincentives on energy consumption levels.

41675 (PB—256202) **An energy demand model for the Swedish residential heating sector.** Bergman, L. (Statens Inst. foer Byggnadsforskning, Stockholm (Sweden)). 1976. 58p. NTIS $4.50.

The report given investigates how the ways that variations in the prices of energy and energy conservation equipment are likely to affect the future demand for energy for residential heating purposes. It develops and applies an energy demand model for the residential heating sector.

41676 Residential space heating: a decision model of the dynamics of fuel penetration. Stover, J. (Futures Group, Glastonbury, CT). pp 753-757 of In Proceedings of the 1976 summer computer simulation conference. La Jolla, CA; Simulation Councils, Inc. (1976).

From Summer computer simulation conference; Washington, District of Columbia, United States of America (USA) (12 Jul 1976).

See CONF-760703—.

A simulation decision model of the dynamics of heating system penetration in the residential space heating sector is presented. The model simulates the decision process of the purchaser of a heating system by defining seven criteria on which the purchase decision is based, and by evaluating each alternative system with respect to these seven decision criteria. An example of the application of the model to residential space heating in Connecticut is also presented.

OFFICE

REFER ALSO TO CITATION(S) 41613

41677 Thermodynamic model of the process of ignition in a diesel engine. Kamfer, G.M.; Komarov, V.A. *Izv. Vyssh. Uchebn. Zaved., Mashinostr.;* No. 5, 112-117(1975). (In Russian).

In this model, heat outflows and sources of heat within the fuel spray torch are substituted for the real process, account being taken of simultaneous compression. Equations obtained in these conditions have made it possible to calculate--for a set pressure in the cylinder--temperature stratification between the fuel spray zone and the remaining cylinder volume from the beginning of injection to the beginning of ignition. A correlation is found between the values of the ignition delay period determined experimentally by means of the pressure curve.

SCHOOL

REFER ALSO TO CITATION(S) 41615, 41616

COMMERCIAL

REFER ALSO TO CITATION(S) 41614

41678 (PB—256006) **Evaluation of energy conservation within health facilities. Final report.** (Transaction Systems, Inc., Atlanta, Ga. (USA)). Sep 1975. 63p. NTIS $4.50.

Four regional energy conferences were staged by the Health Resources Administration (HRA) to increase the awareness of health care facility administrators and engineers concerning the impact of energy shortages on the facility's ability to operate. The conferences were also designed to suggest various strategies to conserve energy or otherwise minimize the impact of rapidly rising fuel costs. A handbook on energy conservation was produced by HRA for use by small facility hospital engineers. Recommendations for further HRA initiatives in the field of energy include: additional conferences, a national blueprint, and a high level policy conference. Appendices contain evaluation forms, conference rosters, and a brochure advertising the conferences. (GRA)

TRANSPORTATION AND PROPULSION

41679 (PB—254854) **Urban goods movement demonstration project design phases I and II. Executive summary.** (Kearney (A.T.), Inc., Chicago, Ill. (USA)). May 1976. Contract DOT-UT-40007. 60p. NTIS $4.50.

See also report dated Dec 1975, PB—249319.

The specific tasks of the Urban Goods Movement Demonstration Project Design Study which are discribed these tasks are: (1) to define quantitatively and qualitatively the impact of goods movement in urban areas on goods movement cost, traffic congestion, energy consumption, air pollution, noise pollution, and land use; (2)

to identify problems associated with urban goods movement and their basic or fundamental causes; and (3) to generate plausible solutions to these problems. Other tasks of the study, not yet complete, are to analyze the potential solutions, to identify those which are particularly desirable and to propose and design demonstration projects to test and/or implement the proposed solutions. This executive summary provides a brief overview of the entire study.

AIR AND AEROSPACE

REFER ALSO TO CITATION(S) 41632, 41738

41680 (AD-A—028888) **Proposed flight simulator technology program. Study project report.** Ortner, A.J. (Defense Systems Management School, Fort Belvoir, Va. (USA)). May 1975. 53p. NTIS $4.50.

This study develops a flight simulator training technology program. Specific goals include identification of: (1) environmental considerations and concerns of DOD, OMB, GAO and Congress; (2) training issues; (3) organizational interfaces and interrelationships; and (4) the process and structure considerations for achieving DOD flight simulator goals in the future. The project derives importance due to the energy crisis and the resultant search for means to conserve fuel and funds. This project researches the above areas for both rationale and a viable approach to: (1) conserve fuels, (2) reduce operating and maintenance costs, and (3) reduce the size of aircraft fleets used for training. Principal conclusions and recommendations center around: (1) achieving OSD goals by concentration upon a high level of substitution of simulator hours for flight hours; (2) utilizing a systems approach to flight simulator development among Aviation Systems Command, Air Mobility Research and Development Lab., Army Research Institute, and Project Manager for Training Devices; (3) standardization of flight training worldwide by strict control of hardware configuration and instructional computer software; and (4) the need for increased simulation research facilities.

41681 (N—76-24144) **Study of the application of advanced technologies to laminar flow control systems for subsonic transports. Volume I. Summary. Final report.** Sturgeon, R.F.; Bennett, J.A.; Etchberger, F.R.; Ferrill, R.S.; Meade, L.E. (Lockheed-Georgia Co., Marietta (USA)). May 1976. Contract NAS1-13694. 63p. (NASA-CR—144975; LG—76ER0076-V-1). NTIS $4.50.

A study was conducted to evaluate the technical and economic feasibility of applying laminar flow control to the wings and empennage of long-range subsonic transport aircraft compatible with initial operation in 1985. For a design mission range of 10,186 km (5500 n mi), advanced technology laminar-flow-control (LFC) and turbulent-flow (TF) aircraft were developed for both 200 and 400-passenger payloads, and compared on the basis of production costs, direct operating costs, and fuel efficiency. Parametric analyses were conducted to establish the optimum geometry for LFC and TF aircraft, advanced LFC system concepts and arrangements were evaluated, and configuration variations maximizing the effectiveness of LFC were developed. For the final LFC aircraft, analyses were conducted to define maintenance costs and procedures, manufacturing costs and procedures, and operational considerations peculiar to LFC aircraft. Compared to the corresponding advanced technology TF transports, the 200- and 400-passenger LFC aircraft realized reductions in fuel consumption up to 28.2%, reductions in direct operating costs up to 8.4%, and improvements in fuel efficiency, in ssm/lb of fuel, up to 39.4%. Compared to current commercial transports at the design range, the LFC study aircraft demonstrate improvements in fuel efficiency up to 131%. Research and technology requirements requisite to the development of LFC transport aircraft were identified.

41682 (N—76-24145) **Study of the application of advanced technologies to laminar-flow control systems for subsonic transports. Volume 2. Analyses. Final report.** Sturgeon, R.F.; Bennett, J.A.; Etchberger, F.R.; Ferrill, R.S.; Meade, L.E. (Lockheed-Georgia Co., Marietta (USA)). May 1976. Contract NAS1-13694. 471p. (NASA-CR—144949; LG—76ER0076-V-2). NTIS $12.00.

LAND AND ROADWAY

REFER ALSO TO CITATION(S) 41701, 41702, 41703, 41704, 41705, 41706, 41707, 41708, 41709

41683 (PB—253713) **Optimizing the use of materials and energy in transportation construction.** (Transportation Research Board, Washington, D.C. (USA)). 1976. 81p. (TRB/SR—166). NTIS $6.00.

The proceedings given include the papers by the four keynote speakers who emphasized the following: the energy crisis is real and serious; how energy implications can affect roadway decision making; the construction materials situation and where materials may be in short supply; and one contractor's view of how energy and materials can be optimized. These papers are followed by the reports of the 7 topic chairmen, a general discussion, and suggestions from state transportation agencies on ways to minimize the impact of energy and material shortages.

41684 (PB—254891) **Development and operational validation of a transit bus simulation. Final research report.** Fairchild, J.E.; Stephens, L.W.; Williams, T.; Simmons, G.A. Jr. (Texas Univ., Arlington (USA). Public Transportation Center). Nov 1975. 99p. NTIS $5.00.

A computer simulation incorporating the significant operational factors and transit bus characteristics has been developed to compute power, fuel consumption, and emissions over an arbitrarily prescribed mission profile. Factors considered include roadway grade, air density, aerodynamic drag, bus center-of-gravity location, front and rear tire inflation pressures, acceleration, weight, and torque converter characteristics. A portable instrumentation package was designed, constructed, and installed on a bus. Operational tests were conducted for a variety of velocity-time profiles for three gross weights. Continuous data recorded included engine speed, torque-converter output shaft speed, fuel flow, electrical load, wind speed and direction, and atmospheric data. Typical mission profiles for an urban transit bus were established by shadowing buses on two most typical routes. The results of the experimental program and mission profile analysis have been used to validate the computer simulation previously developed and to allow the determination of the relative importance of operational and design features on the fuel economy and emission characteristics of a transit bus operating on a realistic mission profile.

41685 (PB—254921) **Effect of energy shortage and land use on automobile occupancy rate. Research report.** Beglinger, R.E.; Behnam, J. (Marquette Univ., Milwaukee, Wis. (USA)). Jun 1975. 39p. NTIS $4.00.

The problem of congested freeways and the low levels of service during the rush hour period is one of the prime concerns in urban transportation. In recent years considerable attention has been directed toward increasing the occupancy rate of automobiles on the freeway system in an effort to reduce the freeway congestion. The characteristics of the automobile occupancy rates in the Milwaukee metropolitan area were investigated by analyzing data for a four-year period to determine the effects of gasoline shortage, land use characteristics, and peak-hour periods on occupancy rates. The fluctuation in the occupancy rates was statistically examined by segregating the land use characteristics of the area into two classifications of low and high intensity areas. Furthermore, the statistical analyses were extended to examine the effects of price increases and unavailability of gasoline on the occupancy rates during the conduct of the study.

41686 (PB—254923) **Macroanalysis of the implications of major modal shifts in integrated regional transportation networks. Final summary report on phase 1.** Billheimer, J.W.; Bullemer, R.; Holoszyc, M. (Systan, Inc., Los Altos, Calif. (USA)). Apr 1976. Contract DOT-OS-50265. 42p. (Systan-D—147). NTIS $4.00.

A macroanalytic approach to the problem of analyzing changing travel patterns in an integrated regionwide transportation network is described. Separate models of residential areas, transportation corridors, and central business districts are combined in a modular representation of urban structure suitable for use in policy analysis and transportation planning. This analytic approach treats demand parametrically, has minimal data requirements, and provides rapid insights into the impacts of alternative patterns of transit and automobile usage. Such impacts as travel time, user costs, congestion, and energy consumption are examined explicity. Application examples discuss the potential economies of scale available from major shifts in current transit usage patterns, tradeoffs between flexible-route and fixed-route systems, and the potential benefits available from policies to reduce the effects of demand peaking.

41687 (PB—254988) **Assessing the relationship between urban form and travel requirements: a literature review and conceptual framework. Research report.** Clark, J.W. (Washington Univ., Seattle (USA). Urban Transportation Program). Aug 1975. Contract FWPCA-WA-11-0003. 47p. (UMTA-URT—3-75-6). NTIS $4.00.

An interest in the development of long-range policy for energy conservation motivates the investigation into the relationship between urban form and transportation energy consumption. Previous studies which have attempted, either directly or indirectly, to cast some light on this relationship are reviewed. A thesis of the paper is that study of the relationship has been hampered by a lack of an operational definition for the concept of urban form. Addressing itself to this need, it is proposed that urban spatial structure be measured in terms of size, shape, and activity distribution of the urbanized area. The review of literature classifies previous studies according to the aspect of urban form which was investigated. Travel requirements appear to increase as urban area population increases, but beyond this finding, no clear relationship between urban form and total urban travel requirements has yet been established in the literature.

41688 (PB—262348) **The influence of tire geometry on the rolling efficiency of commercial vehicle tires. Interim report.** Clark, S.K.; Dodge, R.N. (Michigan Univ., Ann Arbor (USA)). Sep 1976. Contract DOT-OS-50113. 63p. (UMICH—013662-4-T). NTIS, PC A04/MF A01.

A parametric study was conducted of the efficiency with which a pneumatic tire carries a load. The tire is described in terms of its diameter, section width, inflation pressure, and deflection. Both tire load and tire rolling resistance are also expressed in these terms. The ratio of load to rolling resistance is taken as a measure of tire efficiency, and is studied over a wide variety of possible truck tire geometries. Results show only moderate improvements in efficiency for most design possiblities, but when increases in tire load are accompanied by increasing tire inflation pressures, large improvements in rolling efficiency are indicated. These imply substantial reductions in fuel consumption.

INDUSTRY

REFER ALSO TO CITATION(S) 40828, 41590, 41629, 41638

ENERGY SOURCES

REFER ALSO TO CITATION(S) 40735, 40738, 41247

EQUIPMENT AND PROCESSES

REFER ALSO TO CITATION(S) 40973

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 41448

41689 **Waste heat utilisation by 'co-operative' group schemes.** Rowe, W.G.E.; Huxford, R.C. (Pell Morch and Partners). *Plant Eng. (London);* **19**: No. 8, 11-16(Aug 1975).

A district heating system by which groups of factories can participate in the recovery and distribution of low-grade waste heat generated in the course of production is described. A fundamental design approach is outlined which calls for the construction of a central heat and power distribution station and the conversion of existing space and process heating systems to a low-grade application. The proposed distribution station will employ cascade water heaters operating at a condensing vacuum of 10 inch mercury which would provide a water temperature to the secondary system of 190°F. In this way maximum heat extraction and therefore power output is achieved at the turbine while providing the desired water temperature for distribution.

RECYCLING

REFER ALSO TO CITATION(S) 42134

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 41259

41690 (AD-A—034419) **Predictive criteria for construction/demolition solid waste management. Final report.** Chatterjee, S. (Battelle Columbus Labs., Ohio (USA)). Dec 1976. Contract DACA88-74-R-0025. 119p. NTIS, PC A06/MF A01.

The current state of the art of construction solid waste management facilities is reviewed. The available information on solid waste generation rates, composition, disposal alternatives, and disposal costs has been compiled. In addition, data relating to waste generation rates, composition, and disposal costs for selected Army post construction activities have been compiled, analyzed, and documented. Several selected waste management alternatives have been assessed in detail. These alternatives are: waste-to-landfill alternatives, incineration, production of thixite, waste-to-bricks process - tekbricks, ecological/recyycled pavements, wood waste-to-energy alternative, mulching, pulverizer systems, handling of special wastes, and integrated management. Detailed documentation of the assessment analyses was developed. Relevant information relating to these alternatives is summarized.

41691 (PB—253330) **Recovering resources from solid waste using wet processing. EPA's Franklin, Ohio demonstration project.** (Environmental Protection Agency, Rockville, Md. (USA). Solid Waste Management Office). 1974. 30p. (EPA-SW—47d). NTIS $4.00.

As authorized by the Solid Waste Disposal Act of 1965 and its amending legislation, the Resource Recovery Act of 1970, the U.S. Environmental Protection Agency has been aiding local governments and private enterprise in the development and demonstration of various systems of resource recovery. The Franklin, Ohio, project is one of the first successful efforts. This pilot plant is a commercially operated facility that recovers paper, metals, and glass from the city's solid wastes and disposes of the remainder, together with municipal sewage sludge, by methods that do not pollute the land, water, or air. The innovative process involves wet-grinding, fluid separation, resource recovery, and incineration.

41692 (PB—254222) **Recycling trends in the United States: a review. Information circular 1976.** Spendlove, M.J. (Bureau of Mines, College Park, Md. (USA). College Park Metallurgy Research Center). May 1976. 29p. (BM-IC—8711). NTIS $4.00.

Support for recycling in the United States is indicated by the growing deficits in the national economy originating primarily in the mineral supply system. The demand for goods and services of mineral origin has increased markedly in unison with the national economic growth. Concurrently, the Nation's ability to supply these growing demands from domestic resources has faltered seriously. On a value base of current U.S. dollars, the 1971 gross national product (GNP) of $1,055 billion was accompanied by a national mineral deficit of $4 billion. At the end of 1974, the GNP had reached $1,397 billion, and the mineral deficit was $24 billion. The relatively low probability of meeting future deficits by discovering large new domestic resources or by significantly improving minerals supply and/or energy conversion technologies in the near future emphasizes the importance of recycling. The following discussions dwell almost exclusively with situations and systems in the U.S. mineral supply economy. Although no data on other countries are readily available, there is little doubt that similar if not identical parallels can be drawn for any other of the more advanced nations.

41693 (PB—255139) **Resource recovery and source reduction. First report to Congress.** (Environmental Protection Agency, Cincinnati, Ohio (USA). Solid Waste Management Office). 1974. 70p. (EPA-SW—118). NTIS $4.50.

Section 205 of the Solid Waste Disposal Act (Public Law 89-272) as amended requires the U.S. Environmental Protection Agency (EPA) to undertake an investigation and study of resource recovery. This document, which represents EPA's Report to the President and the Congress, summarizes the Agency's investigations to date and reports on the manner in which the congressional mandate is being performed. The findings of this report are based on a number of contractual efforts and analyses by the Agency staff performed since the passage of the Resource Recovery Act. The report is organized into a summary, four major sections, and two appendixes. The first section discusses the problem to which resource recovery is the potential solution. Next, key findings related to resource recovery are presented. A section outlining major options follows. The report concludes with a discussion of EPA's program activities in resource recovery. The appendix presents summaries of information about the status of resource recovery, according to material categories and lists existing resource recovery facilities.

41694 (PB—255141) **Resource recovery and waste reduction. Third report to Congress.** (Environmental Protection Agency, Cincinnati, Ohio (USA). Solid Waste Management Office). 1975. 113p. (EPA/SW—161). NTIS $5.50.

See also PB—253406.

The following topics are discussed: background and perspectives on resource recovery and waste reduction; waste reduction; energy recovery from post-consumer solid waste; materials recovery; resource recovery plant cost estimates; status of waste reduction efforts and implementation of resource recovery systems; Appendix-description of six EPA-supported resource recovery technology demonstrations.

41695 (PB—257955) **Optimization of office paper recovery systems. Final report.** (SCS Engineers, Long Beach, Calif. (USA)). May 1976. Contract EPA-68-01-3192. 83p. NTIS $5.00.

Office building solid waste generally contains a mixture of paper grades and types which, by weight, comprise 85 to 95 percent of quantities generated. The heterogeneous nature of the paper fraction has historically discouraged wastepaper dealers from pursuing office buildings as a primary source of paper stock. Separated from the waste stream at the point of generation, however, can rid recyclable paper of prohibitive contaminants such as carbon paper, bottles, cans, and organic materials. Source separated quantities are then marketable. The study objective was to assess source separation as a viable resource recovery option in office buildings. Three basic approaches to office building source separation were studied in twelve case study locations: desk top; dual basket; and central container.

41696 (PB—258068) **Implementing 'best management practices' for residuals: the waste exchange.** Vitberg, A.K.; Rucker, M.L.; Porter, C.H. (Environmental Protection Agency, Washington, D.C. (USA). Div. of Water Planning). Jun 1976. 31p. (EPA—440/9-76/019). NTIS $4.00.

This document presents an overview of a mechanism which can be used to facilitate the exchange of wastes, as is, from a generator to a user and its possible role in state and areawide residuals planning efforts. The premise is that many wastes contain valuable materials, some of which are in short supply. Extraction of materials from these wastes makes sense from both the conservational and the environmental points of view. Industry can dispose of its unwanted wastes and perhaps receive a monetary bonus. The waste receiver can potentially reduce costs for materials. In addition, the environment is saved from the introduction of potential pollutants from land and water disposal methods. (GRA)

41697 (PB—258260) **Gradd regional solid waste plan.** (Green River Area Development District, Greensboro, Ky. (USA)). May 1975. 144p. NTIS $6.00.

The GRADD Solid Waste Project sees two management possibilities for the seven-county region. Each county could elect to 'go it alone' with individual rural collection systems. The other alternative provides joint operation across the region. The individual operations will provide many local controls. The regional system should be more efficient and cost-effective. A key element in this plan is compatibility. Each collection system should specify the same type of collection equipment (front-end loaders). This will allow the development of joint service by stages in 'building-block' fashion. Compatible collection equipment allows neighboring governments to share equipment in the event of breakdowns. Resource recovery is a major element in plan design. The population base is not adequate to support intensive resource recovery from residential waste at the present time. The plan also provides for reclamation of selected abandoned strip mines. Land is valuable resource. Use of refuse to return this wasted land to use for agriculture or recreation is a valuable form of resource recovery. Concentrating the waste in three regional landfills allows an easy shift to more intensive resource recovery should market conditions change. There is the possibility of establishment of a plant to recover metals from waste and burn the remainder to generate electric power. Landfills could easily become transfer stations moving the waste to the processing plant. (GRA)

41698 (PB—258266) **Decision-makers guide in solid waste management.** Colonna, R.A.; McLaren, C.; Sano, E. (Environmental Protection Agency, Washington, D.C. (USA). Office of Solid Waste Management Program). 1976. 187p. (EPA-SW—500). NTIS $7.50.

See also report dated 1974, PB—255140.

Key issues of solid waste management are discussed in a decision-making context. It attempts to anticipate all of the important decisions which local government managers must make in the effort to develop and operate solid waste programs in a responsive, cost-effective manner. Each chapter presents an issue, describes the alternatives, gives the advantages and disadvantages, and concludes with a summary statement which may include an EPA recommendation on the issue. There are four basic categories of criteria by which decisions are made in the solid waste field: costs, environmental factors, resource conservation, and institutional factors. These criteria determine most decisions in the solid waste field. The cost criteria are among the most important to local managers, and therefore cost information is presented for as many of the issues as possible.

41699 (PB—258773) **Evaluation of proposed man-made ponds for food production to recover values in waste heat and solid organic sludges. Completion report.** Zahradnik, J.W.; Turner, L.S.; Levine, H.L.; Tucker, C. (Massachusetts Univ., Amherst (USA). Water Resources Research Center). Mar 1976. 64p. NTIS $4.50.

An analysis was conducted to determine: (1) the potential value of using, simultaneously, thermal effluents and sewage sludges in aquatic cultures; (2) the technical and economic feasibility of utilizing multilevel aquatic cultures in the recovery of these wastes; and (3) data voids and uncertainties which are of importance in implementation of the system designed. System inputs, potential system outputs and potential subsystem characteristics were characterized and documented through a literature survey.

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

41700 (PB—254945) **Automotive industry in 1974: an international survey. International economics report 1972—1974.** (Office of Economic Research, Washington, D.C. (USA)). Apr 1975. 86p. (OER/ER—8). NTIS $5.00.

The study examines the motor vehicle industry in the United States and eight major foreign automotive industry nations, (Canada, Japan, W. Germany, France, Italy, United Kingdom, Sweden, and Australia). The report opens with a summary of the world motor vehicle situation, then proceeds with individual discussions of the automotive industry in each of the nine countries. While focusing on the automotive situation in 1974, the report also includes discussion on past trends.

41701 (PB—256136) **Macroanalysis of the implications of major modal shifts in integrated regional transportation networks. Final report on phase I.** Billheimer, J.W.; Bullemer, R.; Holoszyc, M. (Systan, Inc., Los Altos, Calif. (USA)). Apr 1976. Contract DOT-OS-50265. 225p. (Systan-D—147). NTIS $7.75.

See also PB—254923, and PB—256137.

The report given describes a macroanalytic approach to the problem of analyzing changing travel patterns in an integrated regionwide transportation network. Separate models of residential areas, transportation corridors, and central business districts are combined in a modular representation of urban structure suitable for use in policy analysis and transportation planning. This analytic approach treats demand parametrically, has minimal data requirements, and provides rapid insights into the impacts of alternative patterns of transit and automobile usage. Such impacts as travel time, user costs, congestion, and energy consumption are examined explicitly. Application examples discuss the potential economies of scale available from major shifts in current transit usage patterns, tradeoffs between flexible-route and fixed-route systems, and the potential benefits available from policies to reduce the effects of demand peaking. (GRA)

41702 (PB—256137) **Macroanalysis of the implications of major modal shifts in integrated regional transportation networks. Phase I: appendices. Final report.** Billheimer, J.W.; Bullemer, R.; Holoszyc, M. (Systan, Inc., Los Altos, Calif. (USA)). Apr 1976. Contract DOT-OS-50265. 115p. (Systan-D—147-App). NTIS $5.50.

See also PB—256136.

The contents of the report given include: cost factors (physical characteristics, capital costs, private auto operating and maintenance costs, private auto parking costs, public transit operating and maintenance costs, allocation of total daily transit system costs between peak and off-peak); performance factors (fuel consumption factors, air pollution factors). (GRA)

41703 **UCOST: a planning, scheduling, and costing system.** Bodin, L.; Rosenfield, D.; Kydes, A. (State Univ. of New York, Stony Brook). pp 795-801 of In Proceedings of the 1976 summer computer simulation conference. La Jolla, CA; Simulation Councils, Inc. (1976).

From Summer computer simulation conference; Washington, District of Columbia, United States of America (USA) (12 Jul 1976).

See CONF-760703—.

UCOST is a software system that has been developed for use by planners in estimating the cost of proposed mass transportation systems. The models in UCOST represent an advancement in the state of the art of transportation planning. To derive these cost estimates, UCOST finds feasible vehicle schedules and an accurate estimate of crew requirements over the day for the proposed multimodal transit system. The approach in UCOST differs from traditional procedures for estimating the cost of these transit systems based on simple characteristics of the transit system such as vehicle in-service hours. UCOST is implemented within the Urban Transportation Planning System (UTPS). A description of the procedures in UCOST and its implementation is presented in this paper.

41704 **Risk analysis and transportation planning.** Roark, A.L. (Schimpeler-Corradino Associates, Louisville, KY). pp 802-806 of In Proceedings of the 1976 summer computer simulation conference. La Jolla, CA; Simulation Councils, Inc. (1976).

From Summer computer simulation conference; Washington, District of Columbia, United States of America (USA) (12 Jul 1976).

See CONF-760703—.

A basic approach to an analytical model for taking into account the uncertainties which can arise in projecting patronage for public transportation systems is presented.

41705 **Station simulation studies for personalized rapid transit urban development.** Korsak, A.J.; Siddiqee, W. (Stanford Research Inst., Menlo Park, CA). pp 954-960 of In Proceedings of the 1976 summer computer simulation conference. La Jolla, CA; Simulation Councils, Inc. (1976).

From Summer computer simulation conference; Washington, District of Columbia, United States of America (USA) (12 Jul 1976).

See CONF-760703—.

Results are presented of simulating an automated rapid transit station in which small personalized cars are served by a variety of berth configurations. The principal aim of the study was to determine station throughputs as a function of berth configurations and traffic flow on main line. Results of simulation studies for five different station configurations are presented. The simulation program can be modified to study other configurations.

41706 **Bus priority system simulator.** Ludwick, J.S. Jr. (MITRE Corp., McLean, VA). pp 961-967 of In Proceedings of the 1976 summer computer simulation conference. La Jolla, CA; Simulation Councils, Inc. (1976).

From Summer computer simulation conference; Washington, District of Columbia, United States of America (USA) (12 Jul 1976).
See CONF-760703—.

To clarify the key factors involved in traffic signal bus priority, an existing computer traffic model has been modified to allow simulation of a variety of bus traffic signal preemption algorithms. Model runs in local, limited, and express service at a variety of headways (one-half minute to four minutes), with bus stops on either the near or the far side of intersections, have been made using buses on links with a variety of traffic volume and signal timing characteristics. This work has identified several factors that are essential to successful application of the traffic signal priority concept, and has in turn revealed other questions that remain to be explored in the further development of such systems.

41707 System analysis, design, and operation of automated guideway transit systems. Thangavelu, K. (De Leuw, Cather, and Co., Denver). pp 968-977 of In Proceedings of the 1976 summer computer simulation conference. La Jolla, CA; Simulation Councils, Inc. (1976).

From Summer computer simulation conference; Washington, District of Columbia, United States of America (USA) (12 Jul 1976).
See CONF-760703—.

The classification of automated guideway transit (AGT) systems and the application of systems analysis methods to establish their preliminary design and operating parameters are described. The interrelationships among network configuration, technology, vehicle and train sizes, station configurations, system safety, control requirements, service policy, system cost and user service levels are analyzed and presented as bases for scientific design of AGT systems. The various AGT system operating strategies are identified and their relationship to network and technology discussed. In particular, the network traffic control strategies and service policies applicable to various classes of AGT systems are analyzed. The application of simulation techniques for operations analysis of AGT systems and to develop inputs for systems analysis is discussed.

41708 Simulating an urban jitney system. Carstarphen, C.; Covington, P.C.; Wardlaw, C.H.; Wood, M.G. (Howard Univ., Washington, DC). pp 978-983 of In Proceedings of the 1976 summer computer simulation conference. La Jolla, CA; Simulation Councils, Inc. (1976).

From Summer computer simulation conference; Washington, District of Columbia, United States of America (USA) (12 Jul 1976).
See CONF-760703—.

In general, a jitney system is one in which the vehicles operate along a fixed route and are hailed by prospective passengers anywhere along the route, but cannot deviate from the route. Vehicles may be owned and operated by individuals, or run in fleets, as in taxi systems. Vehicles may also transport more than one passenger at a time. A simulation model of a one-route jitney system is presented. The underlying purpose of the simulation is to examine the level of service characteristics of jitney systems. The simulation model is designed as a multi-purpose tool for analyzing the behavior of jitney systems operating under various conditions. The user supplies input parameters for three basic entities of the model—route, passengers, and vehicles. Summary statistics including passenger waiting times, line-haul times, percentage of passengers who balk, and vehicle utilization are performance measures for the jitney system being simulated. The measures of effectiveness profile the level of service due to alternative system configurations, i.e., use of various vehicle types, demand distributions, and route lengths. The first section is a description of the model, philosophy, and design. The second section deals with the actual use of the model itself, and its utility for purposes of analysis.

41709 Use of simulation in the design of a dial-a-ride system. Meyer, M.B.; Wilson, N.H.M. (Massachusetts Inst. of Tech., Cambridge). pp 996-999 of In Proceedings of the 1976 summer computer simulation conference. La Jolla, CA; Simulation Councils, Inc. (1976).

From Summer computer simulation conference; Washington, District of Columbia, United States of America (USA) (12 Jul 1976).
See CONF-760703—.

In 1975, the Urban Mass Transportation Administration (UMTA) authorized a demonstration and service development grant for the implementation of a demand-responsive transport service in Rochester, New York. The goals of this new service were: to demonstrate the potential of demand-responsive transportation in a major metropolitan area; to evaluate system operation under computer dispatching; and to test the ability of a Dial-a-Ride (DAR) system to augment and complement an existing transit system. Since 1975, service has been provided in one suburb (Greece) of Rochester with operation in another (Irondequoit) beginning in April of this year. How a simulation model previously developed at the Massachusetts Institute of Technology (MIT) has been used to assist in the design of the Irondequoit system is reported. Specifically, this paper briefly reviews the simulation model itself, then describes the model validation process, the use of the model for evaluating the performance of different system configurations, and further model applications in the design and management of DAR systems.

INTERNAL COMBUSTION ENGINES

REFER ALSO TO CITATION(S) 41688, 41746

41710 (AD-A—034552) Quarterly Bulletin of the Division of Mechanical Engineering and the National Aeronautical Establishment, Ottawa, 1 July to 30 September 1976. (National Research Council of Canada, Ottawa, Ontario). 30 Sep 1976. 130p. (DME/NAE—1976(3)). NTIS, PC A07/MF A01.

Foreword in French.

The airborne concentration of falling snow and a wind tunnel investigation into the fuel savings available from the aerodynamic drag reduction of trucks are discussed.

41711 (PB—255929) Research plan for achieving reduced automotive energy consumption. Iura, T.; Roessler, W.U.; White, H.M. (Aerospace Corp., El Segundo, Calif. (USA). Environment and Energy Conservation Div.). Oct 1975. 375p. (ATR—76(7467)-1). NTIS $10.50.

The report given presents a research program plan aimed at achieving improved fuel economy for internal combustion engines and associated powertrain components as used in passenger cars, trucks, and buses. The types of engines considered include reciprocating and rotary spark ignition gasoline engines, stratified charge variants, and diesel engines. Also included is an assessment of the impact of the potential use of non-petroleum-based alternative fuels on modified or improved internal combustion engines and the research needed to support such future implementation. The research program plan was formulated after an evaluation of internal combustion engine and powertrain alternatives which offer potential for significant reductions in fuel consumption, and a survey of current research in government, universities, and industry (both foreign and domestic). The plan defines needed work in the areas of combustion research, materials research, friction reduction, alternative fuels, engine controls, and diagnostic instrumentation research. Emphasis was placed on identification of near-term (to 1985) benefits. A summary of recent and ongoing research programs in the field is also included.

41712 Prospects of development of internal combustion engines. Orlin, A.S.; Vyrubov, D.N.; Chainov, N.D. (Moscow Higher Tech Sch im. N.E. Bauman, USSR). *Izv. Vyssh. Uchebn. Zaved., Mashinostr.;* No. 4, 63-69(1975). (In Russian).

The state of the art and likely future development of engine construction until about 1990 is considered. In particular, the necessary development of the theory and design of high-boost internal combustion engines is outlined.

41713 Evaluation of radiant heat exchange in the cylinders of internal combustion engines. Rozenblit, G.B.; Levit, A.G. *Energomashinostroenie;* No. 5, 36-38(May 1975). (In Russian).

Based on an analysis of experimental data, a method is proposed for theoretical evaluation of the radiation heat flux according to an experimental or calculated indicator diagram.

41714 Lifting cylinder combustion engine with preheated suction pipe. Gartler, D.J.; Brueggemann, H. (to Daimler-Benz A.G.). German(FRG) Patent 2,510,891/A/. 30 Sep 1976. 5p. (In German).
1 fig.

Suction tube preheating takes place, where the waste gases are taken through a channel in the cylinder head to a preheater box at the inlet manifold, and from there, via a second channel, they are returned to the outlet pipe. In the outlet duct there is a reduction in crossection. There is a temperature-controlled valve at the preheater box for regulating the flow. The valve can be controlled by the cooling water temperature.

SPARK-IGNITION

REFER ALSO TO CITATION(S) 41684

41715 (PB—255091) Life cycle costing for current Rohr and AM general buses and General Motors RTS-II bus. Final report, Mar 1976—Jul 1976. Kain, H.R.; Marks, G.J.; Staszak, L.A. (Advanced Management Systems, Inc., McLean, Va. (USA)). 9 Jul 1976. Contract DOT-UT-60066. 46p. NTIS $4.00.

UMTA is considering the use of the life cycle costing concept in the procurement procedures for intracity buses. These relevant factors have been identified as the bus price, maintenance costs (including preventive maintenance), fuel costs, and tire costs. Evaluation of practices of bus operators and manufacturers indicates that they are in a position to agree mutually upon an evaluation process dependent upon: (1) maintenance cost data, (2) design-related maintenance elements, (3) fuel and tire costs, (4) useful life of a bus for

evaluation purposes, and (5) initial bus purchase price. Inasmuch as the follow-on costs considered in the evaluation of bus bids exceed the cost of the bus itself, the life cycle costing approach highlights the follow-on costs. Of paramount importance is the flexibility to introduce design improvements that can result in savings during the life of the bus.

41716 (PB—256220) **Study of stratified charge for light duty power plants. Volume I. Final report.** (Environmental Protection Agency, Ann Arbor, Mich. (USA)). Oct 1975. Contract EPA-68-03-0375. 329p. (DP—20437-Vol-1). NTIS $10.00.

See also PB—236896.

The objectives of the project described were to determine the acceptability of various types of stratified charge engines as potential power plants for light duty vehicles and motorcycles in America. A literature survey was undertaken, comparing stratified charge engines with examples of good conventional gasoline and diesel engines. While some stratified charge engines had exhaust emission or fuel economy advantages, there were always sacrifices in other areas. Eleven engines were configured, four of which were specifically directed towards the secondary emission targets. A method of rating the engines was derived, and the design concepts were compared with two gasoline engines by a jury panel. The overall result was that the Ford PROCO and Honda CVCC combustion processes were serious contenders to the gasoline engine at the primary emission target, and that both of these systems, together with the VW combustion process, might be suitable at the secondary targets.

41717 (PB—256221) **Study of stratified charge for light duty power plants: Volume 3. Executive summary. Final report.** (Environmental Protection Agency, Ann Arbor, Mich. (USA)). Oct 1975. Contract EPA-68-03-0375. 37p. (DP—20437-Vol-3). NTIS $4.00.

See also Volume 2, PB—253767.

The objectives of the project described were to determine the acceptability of various types of stratified charge engines as potential power plants for light duty vehicles and motorcycles in America. The light duty vehicle considered was a 4/5 seat compact sedan with good acceleration capabilities and exhaust emissions below a primary target of 0.41 g/mile HC, 3.4 g/mile CO, 1.5 g/mile NOx. A secondary target of 0.41 g/mile HC, 3.4 g/mile CO and 0.4 g/mile NOx was also considered. A literature survey was undertaken, comparing stratified charge engines with examples of good conventional gasoline and diesel engines. While some stratified charge engines had exhaust emission or fuel economy advantages, there were always sacrifices in other areas. Eleven engines were configured, four of which were specifically directed towards the secondary emission targets. A method of rating the engines was derived, and the design concepts were compared with two gasoline engines by a jury panel. The overall result was that the Ford PROCO and Honda CVCC combustion processes were serious contenders to the gasoline engine at the primary emission target, and that both of these systems, together with the VW combustion process, might be suitable at the secondary targets.

DIESEL

REFER ALSO TO CITATION(S) 41744, 41745, 41748, 41749, 41751

41718 Theoretical and experimental determination of instantaneous air flow in a combined diesel in unsteady conditions. Leonov, O.B.; Dolinskii, G.I. *Izv. Vyssh. Uchebn. Zaved., Mashinostr.;* No. 4, 90-93(1975). (In Russian).

Based on experimental data, pressure diagrams and resolution of a system of equations, a method is proposed enabling one to determine, at any moment of time (by the angle of turn of the crankshaft), the parameters of air flow and the consumption of air for charging each cylinder of a combined diesel engine.

41719 Investigation of throughput capacity of a four-stroke diesel engine during the closing of valves. Nechaev, L.V.; Balashov, A.A.; Strebkova, T.F.; Pyatkov, V.P. *Izv. Vyssh. Uchebn. Zaved., Mashinostr.;* No. 4, 94-98(1975). (In Russian).

Experimental data are presented on 'dynamic' scavenging of the ducts and valves of the Soviet D6 diesel engine. A method of determination of the effective passage cross-section and the conventional discharge coefficient during the period when valves are closed is considered.

41720 Thermophysical analysis of gas-phase processes developing in space and time in diesel units. Seleznev, Yu.V. (Kharkov Inst of Electron, Ukr SSR). *Heat Transfer - Sov. Res.;* 7: No. 2, 140-144(1975).

An arbitrary thermal and gasdynamic process, developing in time, is considered. Principal thermodynamic relationships for the time process are obtained. A model is suggested of an open time cycle for a heat engine. Using a reciprocating diesel engine as an example, the application of the thus-derived equations in calculating indicator diagrams in time with allowance for the fuel injection mode, is demonstrated.

41721 Cyclic temperature fluctuations in marine diesel combustion chamber walls. Ivanov, L.A.; Nadviga, G.S.; Pashentsev, S.V. *Energomashinostroenie;* No. 5, 25-27(May 1975). (In Russian).

An approximate method is set forth for the calculation of cyclic temperature fluctuations in the cylinder wall of a marine diesel engine. This method avoids difficulties presented by the existing methods of determination of the unknown constants of the equation derived by Eichelberg for space-time distribution of temperature in the cylinder wall.

41722 Techniques for quieting the diesel. *Automot. Eng. (N.Y.);* **83**: No. 9, 34-39(Sep 1975).

Reducing diesel engine noise in a cost effective way requires a positive identification of the noise levels radiated by different engine surfaces. Proper stiffness and mass distribution can provide 3 to 4 dB(A) reductions, but must be balanced against weight limitations. Shielding various engine parts is effective when properly designed with adequate transmission loss, sealing, isolation, and area coverage. Damping is particularly effective where noise is due to radiation from resonant vibration modes. For engine covers, maximum reductions of 5 to 6 dB(A) are typical. Isolation of engine components is effective, especially at higher frequencies.

41723 Influence of diesel fuel cetane number on operating indices of engine. Malyavinskii, L.V.; Rossinskii, V.M. *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 1-2, 144-146(1976).

One of the primary indices of diesel fuel quality, an index characterizing the susceptibility of the fuel to spontaneous ignition upon compression, is the cetane number (CN); the CN level of the fuel influences the starting properties and the parameters of the engine operating cycle. Results of an investigation are presented which show that an increase in the cetane number of winter and arctic diesel fuels from 40 (GOST 4749-49) to 45 (GOST 4749-73) leads to a decrease in the dynamic stress of the operating cycle in automotive/tractor engines amounting to at least 30%, so that the time between overhauls can be increased. The use of high-cetane fuels (50 and up) brings about a progressive increase in specific fuel consumption and in exhaust smoke. 2 refs.

TURBINE

REFER ALSO TO CITATION(S) 41680

ROTARY

REFER ALSO TO CITATION(S) 41682

41724 Rotary piston combustion engine. Hofbauer, P. (to Volkswagenwerk A.G.). German(FRG) Patent 2,405,557/A/. 7 Aug 1975. 15p. (In German).

6 figs.

The invention deals with a rotary piston combustion engine. It has been shown that in the region of the top dead center of the piston sections having inlet and outlet openings, an overlapping of inlet and outlet channel occurs in the individual working chambers. The gas change losses occuring during the overlapping reduce the efficiency of the machine. The invention improves the gas change control by designing additional spring flap traps in the inlet channels. These flap traps prevent refluxing of waste gas through the inlet channel into the working chambers.

EXTERNAL COMBUSTION ENGINES

STIRLING CYCLE

41725 Closed vapor cycle engine operated with trifluorethanol/ammonia as the working fluid. Davis, J.P. (to Thermo Electron Corp.). German(FRG) Patent 2,615,663/A/. 28 Oct 1976. 13p. (In German).

1 fig.; 1 tab.

An engine is described with a closed vapor circuit. The engine parts consist of an iron alloy. Trifluoroethanol is used as fuel which contains ammonia in a quantity to prevent a corrosion of the engine parts. The engine components are: an evaporation system to vaporize the fuel, an expansion system, and a condenser to cool and pre-liquefy the expanded gaseous working medium. The vapor generator makes use of the heat given off by a burner or another system, e.g., the waste heat of an internal combustion engine may be used to evaporate the working medium.

RANKINE CYCLE

41726 (ERDA—77-54) **Assessment of the technology of Rankine engines for automobiles.** Luchter, S.; Renner, R.A. (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Transportation Energy Conservation). Apr 1977. 96p. Dep. NTIS, PC A05/MF A01.

During the past 7 years, much work has been accomplished in advancing the development of the Rankine-powered automobile. A critical review is given of the work, with emphasis on the Federal Government's development program. The information is presented in four major parts. The section on the state of the art in 1970 describes where the technology was prior to the Government development program. The section describing the program initiated within the Environmental Protection Agency and concluded by the Energy Research and Development Administration presents an overview of the components and systems. A third section describes the work done during this same period by other government agencies and by private developers. Finally, the state of the art as it exists today is presented. The major conclusions of the report are that the Rankine engine can provide very low emissions, that the fuel economy is not competitive with spark-ignition or projected alternative engines at this time, and that there is some evidence that a variety of fuels could be easily utilized in Rankine engines.

41727 Steam piston engine. Gross, K.; Maidl, J. German(FRG) Patent 2,405,380/A/. 14 Aug 1975. 9p. (In German).

1 fig.

The invention deals with a steam piston engine. As opposed to the usual machines of this kind, the steam is not generated in a separate steam generator but directly in the cylinder. The cylinder is thus heated, preferably electrically. Shortly before the upper dead center, water is injected into the cylinder which evaporates immediately and to operate the piston. Waste steam flows around the cylinder from outside additionally heating it. The water is injected through a pump driven and controlled by the crank shaft using a nozzle in the cylinder head.

41728 Hydraulic heat engine. Rupp, O. German(FRG) Patent 2,458,144/A/. 10 Jun 1976. 5p. (In German).

1 fig. Addition to P2321267.1.

A heat engine is described for converting heat energy into mechanical energy. The equipment consists of a motor, pump, heat exchanger, heater, cooler and pressure-volume regulator. The heat exchanger is dimensioned in such a way that only 10°K temperature increase needs to be provided by the heater, and the temperature drop starts at 20°K and above over the critical pressure and temperature area of the liquefied gas used. Freon is used as the heat exchange medium. The heat engine permits a better use of waste heat than steam- or gas-turbine equipment.

ELECTRIC-POWERED SYSTEMS

41729 (PB—255048) Procedure for optimizing rapid transit car design. Project report. Huss, M.F. (Polytechnic Inst. of New York, Brooklyn (USA). Dept. of Transportation Planning and Engineering). May 1975. 248p. NTIS $8.00.

A methodology for creating an initial rough design of a rail rapid transit car, or for evaluating an existing design is presented. It is based on optimizing the design features by minimizing the sum of the annual costs of purchasing, power consumption, maintenance, and on-board operating labor for a fleet of such vehicles. Linear programming is used to arrive at a solution based on the interaction of several hundred equations which describe the complex interrelationships amongst the elements of car design, dimensions, and performance, and the various components and sub-assemblies which comprise the vehicle, and the associated costs.

41730 Power supply system, particularly for the supply of auxiliary devices of a passenger cars with energy from the electric contact line. Seeger, H. (to Krupp (Friedr.) G.m.b.H.). German(FRG) Patent 2,456,192/A/. 12 Aug 1976. 9p. (In German).

1 fig.

The auxiliary devices of passenger cars are mainly supplied with electrical energy from the contact line. Failures can occur with this kind of energy supply when the bow collector breaks so that the electrical contact is temporarily interrupted. With the systems now in use, there is a danger that the moment where the bow collector is contacted again with the contact line, a short circuit occurs in the car and the fuse is released. An electric circuit is described excluding the above-mentioned danger.

41731 Electrodynamic levitated train. Erlangen large-scale test plant is being converted to long stator technology. Muckelberg, E. *VDI (Ver. Dtsch. Ing.) Nachr.;* **30**: No. 40, 17-18(Oct 1976). (In German).

With figs.

The development work for a future high-power fast train have been marked for years by the competition of two magnetic levitation systems, i.e., the electrodynamic levitation system (EDS) with superconducting magnets and the electromagnetic levitation system (EMS). The present study particularly deals with the EDS system. The vehicle is driven by a linear motor. The levitation height is between 10 cm and 30 cm without any complicated control in the EDS system. The disadvantage with this system, however, is that a starting and landing device is needed as a certain starting speed is required before the levitation process fully begins. The first levitation tests were possible on a round course at the beginning of May 1976. A second test stand is being put into operation at present. The first results are reported. Finally, possible development trends are indicated. It seems possible that the end project 'high-power fast train' will be a combination of the EMS and EDS systems.

41732 Battery-electric road transport as part of an aggregate transport system. Budde, H.J. (GES Gesellschaft fuer Elektrischen Strassenverkehr m.b.H., Duesseldorf (Germany, F.R.)). *Elektrotech. Z., A;* **98**: No. 1, 10-16(Jan 1977). (In German).

From 4. international electric vehicle symposium; Duesseldorf, Germany, F.R. (31 Aug 1976).

3 figs.; 3 tabs.; 29 refs.

After a historical review of transport systems operating on the ground, in the water, in the air, and which are not confined to one system, the propulsion systems for modern traffic carriers for goods and passengers are analyzed. In view of the practically complete dependence of road traffic on mineral oil, its conversion to substitute energies for technical and economic reasons is discussed. Three conditions must be met: (1) a suitable energy supply; (2) a vehicle and drive design; and (3) economic competitive capability. A possible substitute for electric vehicles for short-distance traffic is discussed. A few comments from the point of view of the general economy are included.

41733 DUO-bus, supplied either from overhead wire or from battery alternatively. Domann, H.; Wirtz, R. (Bosch (R.) G.m.b.H., Stuttgart (Germany, F.R.). Unternehmensbereich Kraftfahrzeugtechnik). *Elektrotech. Z., A;* **98**: No. 1, 51-54(Jan 1977). (In German).

From 4. international electric vehicle symposium; Duesseldorf, Germany, F.R. (31 Aug 1976).

8 figs.; 4 refs.

The propulsion system design for a dual bus with alternative overhead-line operation is described. The first operational experience is also described.

HYBRID SYSTEMS

41734 Hybrid-engine. Renner, E. German(FRG) Patent 2,414,147/A/. 9 Oct 1975. 5p. (In German).

1 fig.

A hybrid engine is introduced for driving motor vehicles. The hybrid engine consists of a conventional internal combustion engine with a subsequent catalytic or pyrolytic after burner arrangement to destroy the noxious substances in the exhaust gas. After the after burner arrangement there is a heat exchanger, which conducts the heat generated by the after burner into a circuit, which includes a steam engine. The working fluid for this circuit is one having a low boiling point and a low latent heat of vaporization. There is a transmission gearbox between the internal combustion engine and the steam engine.

VEHICLE DESIGN FACTORS

41735 (N—76-27164) Cargo transportation by airships: a systems study. Final report. Huang, C.J.; Dalton, C. (Houston Univ., Tex. (USA)). May 1976. 196p. (NASA-CR—2636;S—452). NTIS, PC A09/MF A01.

A systems engineering study of a lighter than air airship transportation system was conducted. The feasibility of the use of airships in hauling cargo was demonstrated. Social, legal, environmental and political factors were considered as well as the technical factors necessary to design an effective airship transportation system. In order to accomplish an effective airship transportation program two phases of implementation were recommended. Phase I would involve a fleet of rigid airships of 3.5 million cubic feet displacement capable of carrying 25 tons of cargo internal to the helium-filled gas bag. The Phase I fleet would demonstrate the economic and technical feasibility of modern-day airships while providing a training capability for the construction and operation of larger airships. The Phase II portion would be a fleet of rigid airships of 12 million cubic feet displacement capable of carrying a cargo of 100 tons a distance of 2,000 miles at a cruising speed of 60 mph. An economic analysis is given for a variety of missions for both Phase I and Phase II airships.

41736 (N—76-28224) Study of operational parameters impacting helicopter fuel consumption. Cross, J.L.; Stevens, D.D. (National Aeronautics and Space Administration, Langley Station, Va. (USA). Langley Research Center). Jul 1976. 42p. (NASA-TM-X—73922). NTIS $4.00.

No abstract available. (GRA)

41737 (N—76-29064) **Suburb-to-suburb intercity travel: energy, time and dollar expenditures.** Fels, M.F. (Princeton Univ., N.J. (USA). Center for Environmental Studies). Jun 1976. 70p. (NASA-CR—137911;REPT—76-TR-10). NTIS, PC A04/MF A01.

The effect of adding suburb to terminal and terminal to suburb travel is examined. The energy consumed in entire trips was estimated. The total energy costs are compared with total travel times, and dollar costs to the traveler. Trips between origins in seven suburbs of Newark, New Jersey and destinations in two Washington, D. C. suburbs are analyzed.

41738 (N—76-29188) **Study of short-haul aircraft operating economics. Phase 2: an analysis of the impact of jet modernization on local service airline operating costs. Final report.** Andrastek, D.A. (Douglas Aircraft Co., Inc., Long Beach, Calif. (USA)). May 1976. Contract NAS2-8549. 155p. (NASA-CR—137863;MDC-J—7245). NTIS $6.75.

The objectives of this phase of the study were (1) to assess the 10 year operating cost trends of the local service airlines operating in the 1965 through 1974 period, (2) to glean from these trends the technological and operational parameters which were impacted most significantly by the transition to newer pure jet, short haul transports, and effected by changing fuel prices and cost of living indices, and (3) to develop, construct, and evaluate an operating cost forecasting model which would incorporate those factors which best predicted airline total operating cost behavior over that 10-year period.

41739 (PB—257409) **Energy savings resulting from modal shifts to Corridorrail.** Sokolsky, S. (Aerospace Corp., El Segundo, Calif. (USA). Energy and Transportation Div.). Jul 1975. Contract DOT-TSC-936. 34p. NTIS $4.00.

A high speed passenger rail service between Washington and Boston was called for in the Regional Rail Reorganization Act of 1973. Planning for the service has been conducted by the Office of Northeast Corridor Development in the Federal Railroad Administration. Engineering studies were undertaken to develop detailed plans and costs for the required facilities improvements. Train resistance, train performance, train energy consumption, and arena energy use characteristics are examined.

41740 (PB—258344) **Subsurface exploration methods for soft ground rapid transit tunnels. Volume II: Appendixes A-F. Final report Jun 73—Jun 75.** Schmidt, B.; Matarazzi, B.; Dunnicliff, C.J.; Alsup, S. (Parsons, Brinckerhoff, Quade and Douglas, Inc., New York (USA)). Apr 1976. Contract DOT-TSC-654. 144p. NTIS $6.00.

This study assesses subsurface exploration methods with respect to their ability to provide adequate data for the construction of rapid transit, soft-ground bored and cut-and-cover tunnels. Geophysical and other exploration tools not now widely used in urban underground construction are investigated, their potential is discussed, and performance specifications and ideas for future development are presented. The effect of geotechnical variations on construction costs is modeled, and the effect of the prior knowledge of variation, including preliminary designs, specifications, cost estimates, and development plans, are formulated. Volume two contains Appendixes A-F.

BODY AND CHASSIS

41741 (PB—254571) **Study of aerodynamic drag reduction on a full-scale tractor-trailer. Final report, Mar—Dec 1974.** Steers, L.L.; Montoya, L.C. (National Aeronautics and Space Administration, Edwards AFB, Calif. (USA). Dryden Flight Research Center). Apr 1976. Contract DOT/TSC-RA-74-31. 57p. NTIS $4.50.

Aerodynamic drag tests were performed on a tractor-trailer combination using the coast-down method on a smooth, nearly level runway. The tests included an investigation of drag reduction obtained with add-on devices that are commercially available or under development. The tests covered tractor-trailer speeds ranging from approximately 35 to 65 miles per hour and included fuel consumption measurements. The study shows the effects of the various add-on devices on the aerodynamic drag, and for some devices on the fuel consumption. Results from a simulation of fuel consumption tests using a computer program are also included. (GRA)

ENGINE-TRANSMISSION MATCHING

REFER ALSO TO CITATION(S) 41711

ENGINE SYSTEM

REFER ALSO TO CITATION(S) 41711

41742 (N—76-29233) **Study of unconventional aircraft engines designed for low energy consumption. Final report.** Gray, D.E. (Pratt and Whitney Aircraft, East Hartford, Conn. (USA)). Jun 1976. Contract NAS3-19465. 142p. (NASA-CR—135065;PWA—5434). NTIS $6.00.

Declining U.S. oil reserves and escalating energy costs underline the need for reducing fuel consumption in aircraft engines. The most promising unconventional aircraft engines based on their potential for fuel savings and improved economics are identified. The engines installed in both a long-range and medium-range aircraft were evaluated. Projected technology advances are identified and evaluated for their state-of-readiness for application to a commercial transport. Programs are recommended for developing the necessary technology.

41743 (N—76-30218) **Study of turbofan engines designed for low enery consumption.** Neitzel, R.E.; Hirschkron, R.; Johnston, R.P. (General Electric Co., Cincinnati, Ohio (USA). Aircraft Engine Group). Aug 1976. Contract NAS3-19201. 144p. (NASA-CR—135053;R—76AEG432). NTIS $6.00.

Subsonic transport turbofan engine design and technology features which have promise of improving aircraft energy consumption are described. Task I addressed the selection and evaluation of features for the CF6 family of engines in current aircraft, and growth models of these aircraft. Task II involved cycle studies and the evaluation of technology features for advanced technology turbofans, consistent with initial service in 1985. Task III pursued the refined analysis of a specific design of an advanced technology turbofan engine selected as the result of Task II studies. In all of the above, the impact upon aircraft economics, as well as energy consumption, was evaluated. Task IV summarized recommendations for technology developments which would be necessary to achieve the improvements in energy consumption identified.

41744 **Effect of the stroke/bore ratio on the M diesel engine.** Kampmann, H.J. (IFA Motorenwerke Nordhausen, E Ger). *Wiss. Z. Tech. Univ. Dresden;* **24**: No. 1, 227-233(1975). (In German).

The optimum stroke/bore ratio with respect to efficiency, load carrying capacity and small concentrations of noxious substances in exhaust gases is determined for M diesel engines by means of experiments with engines and with the mixture-forming devices. In order to be able to compare different engines in this respect, theoretical investigations are carried out. It is concluded that the optimum stroke/bore ratio is about 1.3 in M diesel engines.

41745 **Effect of the stroke/bore ratio in a vehicle diesel engine with special regard to the combustion process in a hyperboloid combustion chamber.** Steinmetz, W. (IFA-Motorenwerke Nordhausen, E Ger). *Wiss. Z. Tech. Univ. Dresden;* **24**: No. 1, 235-243(1975). (In German).

The stroke/bore ratio has a considerable effect on all the characteristics of a combustion engine. By comparing results of investigations of diesel engines with a constant bore and a varying stroke the effect of the stroke/bore ratio on the efficiency, maximum load carrying capacity, power concentration, and emission of noxious substances can be determined. From these particular criteria an optimum can be derived for different applications. Special attention is devoted to an investigation of the optimum arrangement of fuel injection in a hyperboloid combustion chamber.

41746 **Classification and systematization of possible combined engine schemes.** Mizernyuk, G.N.; Bezborodov, A.I. *Izv. Vyssh. Uchebn. Zaved., Mashinostr.;* No. 5, 118-121(1975). (In Russian).

A classification of combined engines by the type of coupling between the piston section and the bladed section is proposed. All the realized and proposed schemes of combined internal combustion engines are divided into 10 groups. In each group, schemes are arranged in a certain sequence, according to the increase of their basic elements constituting the combined engine.

41747 **Sound transmission in the 180° duct bends of rectangular section.** Cummings, A. (Univ of Southampton, Engl). *J. Sound Vib.;* **41**: No. 3, 321-334(8 Aug 1975).

There recently has been increased interest in prediction of the performance of exhaust silencers for internal combustion engines with the object of making silencer design more definitive. With the need for increasingly compact silencers, it has been found to be useful, in the design of reactive expansion-chamber silencers, to convolute the silencer chambers in order to extend their effective lengths. Sound transmission in 180° rectangular bends in rectangular section ducts is studied. Two models, a potential flow approach and an acoustic modal solution, are used, and the relative accuracy of the results is assessed by comparison with experimental data. An accurate method of predicting the bend's behavior is described.

EMISSION CONTROL

REFER ALSO TO CITATION(S) 41744, 41745

41748 **Diesel emissions measurement and control.** Hurn, R.W. Bartlesville, OH; Bartlesville Energy Research Center (1975). vp.

A discussion is given focusing upon one aspect of diesel engine use--control of its exhaust product. To place the problems of

diesel emission control in proper context, it would be well to attempt a correction of two widely held misconceptions about the characteristics of the diesel engine. The first of the two misconceptions is that the diesel, by its inherent nature, produces a dirty exhaust--dirty in the sense of being heavily loaded with objectionable pollutants. the fact is that diesel exhaust is not inherently 'dirty'. In fact, in comparison with spark ignition engines typical of production only a few years ago, the diesel produces exhaust that is relatively 'clean'. A well-designed, well-adjusted, well-maintained diesel engine need not smoke excessively, need not produce malodorous exhaust, and typically will produce carbon monoxide only at very low concentrations compared with unmodified exhaust of the spark ignition engine. The second of the misconceptions is that the diesel engine does not--even by some representations cannot--produce toxic exhaust. The fact is that a diesel engine typically does produce toxic gases, and it is indeed a very dangerous misconception to hold that the diesel generates no toxic material. The point of emphasis is the need to understand that diesel engines do in fact produce toxic combustion products but that the diesel family is not inherently 'dirty' and that the toxic products are controllable at acceptable levels.

41749 Toxicology of diesel emissions. Stokinger, H.E. Cincinnati; National Institute for Occupational Safety and Health (1975). vp.

The almost unending complexity of diesel emissions with respect to their chemical constituents has been increasingly revealed, as evermore sensitive and specific procedures have been used for their analysis and identification. However, the character and amount of the complex exhaust mixture is drastically altered by changes in power output, motor speed, engine design and load, and fuel additives. Lack of proper engine maintenance further modifies the nature and amount of emissions. So, despite analytic advances, chemical characterization of diesel emissions is still far more complete, either as to type or amount of the various compounds. Analytic investigators often fail to agree on some classifications of emission components or fail to analyze for the same constituents, leaving comparison gaps. These uncertainties and unknowns, coupled with potential toxicologic interactions among the exhaust consituents, make it extremely difficult to make a definitive toxicologic evaluation, or to suggest anything but highly tentative air standards.

NITROGEN OXIDES

41750 (N—76-28429) **Experimental clean combustor program, Phase 2.** Roberts, R.; Peduzzi, A.; Vitti, G.E. (Pratt and Whitney Aircraft, East Hartford, Conn. (USA)). Jul 1976. Contract NAS3-18544. 86p. (NASA-CR—134970;PWA—5370). NTIS $5.00.

The alternate fuels investigation objective was to experimentally determine the impacts, if any, on exhaust emissions, performance, and durability characteristics of the hybrid and vorbix low pollution combustor concepts when operated on test fuels which simulate composition and property changes which might result from future broadened aviation turbine fuel specifications or use of synthetically derived crude feedstocks. Results of the program indicate a significant increase in CO and small NOx increase in emissions at idle for both combustor concepts, and an increase in THC for the vorbix concept. Minimal impact was observed on gaseous emissions at high power. The vorbix concept exhibited significant increase in exhaust smoke with increasing fuel aromatic content. Altitude stability was not affected for the vorbix combustor, but was substantially reduced for the hybrid concept. Severe carbon deposition was observed in both combustors following limited endurance testing with No. 2 home heat fuel. Liner temperature levels were insensitive to variations in aromatic content over the range of conditions investigated.

41751 Turbocooling and noSsub xS-emission reduction of diesel engines. Kalmar, I.; Antal, J. (Tech Univ, Budapest, Hung). *Period. Polytech., Mech. Eng.;* **19**: No. 1, 57-67(1975). (In German).

Turbocooled supercharging is considered for reducing the NOSsub xS-emission of diesel engines. A digital model was developed to study the common operating processes of the diesel engine, turbocharger and turbocooler. With the aid of this model it was possible to determine numerically the effect of turbocooler-turbocharger variants collected from various conditions on the engine characteristics.

CARBON MONOXIDE

REFER ALSO TO CITATION(S) 41750

HYDROCARBONS

REFER ALSO TO CITATION(S) 41750

41752 New methods for reducing visible emissions of diesel engines. Fraenkle, G.; Hardenberg, H.O. (Daimler-Benz, Ger). *SAE Prepr.;* No. 750772, vp(1975).

It is general practice today when starting diesel engines to inject excess fuel, i.e. an additional amount of fuel in excess of the full load quantity, independent of ambient and engine temperatures and regardless of whether this is necessary or not. It is demonstrated that excess fuel should only be injected when starting a cold engine at ambient temperatures below freezing point and that the quantity of excess fuel should increase with falling temperature, reaching its maximum at the minimum engine starting temperature. A burner starting aid of simple design and fully automatic operation is described, which has been newly developed and is used to suppress, or even to eliminate, the emission of white and blue smoke during cold start and warm-up.

ALTERNATIVE FUELS

REFER ALSO TO CITATION(S) 41711

41753 (AD-A—026666) **Potential of liquid hydrogen as a military aircraft fuel.** Mikolowsky, W.T.; Noggle, L.W. (RAND Corp., Washington, D.C. (USA)). Feb 1976. 15p. (P—5577). NTIS $3.50.

Liquid hydrogen does not appear to be attractive as a military aircraft fuel for the immediate future. In a wide variety of mission applications, liquid hydrogen is less cost-effective and less energy-effective than the available alternative. Indications are that synthetic jet-fuel is the most attractive alternative fuel for very large airplanes. At the least, this conclusion appears valid until coal reserves are substantially depleted. (Even for relatively high growth rates in coal consumption, domestic coal production is not likely to peak much before the second quarter of the 21st century). This conclusion is substantially strengthened when one realizes that airplanes using a conventional jet-fuel have the potential for a much greater payoff from advances in fuel-conserving aircraft technology. Furthermore, these conclusions prevailed despite our favorable assumptions toward liquid hydrogen in several important instances (e.g., aerial refueling). In summary, there is little, if any, potential for liquid hydrogen as a fuel for aircraft entering the Air Force inventory between now and the end of the century.

41754 Method for production of a gas mixture using a catalytically converted fuel and a gas serving as oxygen carrier. Kostka, H.; Henkel, H.J. (to Siemens A.G.). German(FRG) Patent 2,454,084/A/ . 26 May 1976. 7p. (In German).

1 fig. Addition to P2232506.0.

A process is described for the production of a gas mixture, particularly for internal combustion engines. The gas mixture consists of a gas obtained by catalytic conversion of a fuel and a second gas as oxygen carrier. A part of the fuel not converted in the first stage of the reaction is taken to a subsequent second stage of the reaction. After the last stage of the reaction, a coolant is introduced into the mixture, so that the walls of the vessel containing the gas mixture are largely shielded from the hot gas mixture, so that decomposition of the gas mixture produced is avoided during cooling. Gasoline or water in finely divided form is sprayed in as cooling fluid.

MATERIALS

41755 (AD-A—028846) **Annual technical report, July 1, 1975-June 30, 1976.** (Chicago Univ., Ill. (USA). Materials Research Lab.). 30 Jun 1976. 66p. NTIS $4.50.

Contents: I. Disordered Materials -- A. Personnel, B. Summary and Objectives, C. Selected Accomplishments (1975-1976), D. Publications Which Received Substantial Support from NSF-MRL (1975-1976); II. Materials at High Pressures and High Temperatures -- A. Personnel, B. Summary and Objectives, C. Selected Accomplishments (1975-1976), D. Publications Which Received Substantial Support from NSF-MRL(1975-1976); III. Junior MRL Faculty Research -- A. Personnel, B. Summary and Objectives, C. Selected Accomplishments (1975-1976), D. Publications Which Received Substantial Support from NSF-MRL (1975-1976). (GRA)

METALS AND ALLOYS

REFER ALSO TO CITATION(S) 41049

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 40735

41756 (AD-A—030274) **High-toughness titanium alloy development. Final engineering report Jan 1975—May 1976.** Berryman. R.G.;

Chesnutt, J.C.; Froes, F.H.; Rhodes, C.G. (Rockwell International Corp., Los Angeles, Calif. (USA). Los Angeles Aircraft Div.). Jun 1976. Contract N00019-75-C-0208. 50p. (TFD—76-471). NTIS $4.00.
See also report dated Jul 75, AD-A017 452.

This is the final engineering report for a Naval Air Systems Command sponsored program to evaluate the forgeability characteristics of CORONA-5, a new titanium alloy with a nominal composition of Ti—4.5Al—5Mo—1.5Cr. The goal of this contract was to define forging and final heat treat parameters which would produce optimum or near-optimum toughness over the strength range of 130—140 ksi (about 900—965 MPa), UTS. During this program, a total of six different forging sequences were evaluated to identify effects of varying degrees of alpha/beta working on resultant microstructures and attendant mechanical properties. In addition, two different final heat treat cycles were employed to provide strength variations over the goal range. The results of these evaluations indicated that the best combinations of strength and toughness were produced by forging the material above its beta transus or at temperatures high in the alpha plus beta region. (GRA)

41757 (N—76-27401) **M551 metals melting experiment.** Li, C.H.; Busch, G.; Creter, C. (Grumman Aerospace Corp., Bethpage, N.Y. (USA)). Feb 1976. Contract NAS8-28728. 26p. (NASA-CR—149927; RM—613). NTIS.

The Metals Melting Skylab Experiment consisted of selectively melting, in sequence, three rotating discs made of aluminum alloy, stainless steel, and tantalum alloy. For comparison, three other discs of the same three materials were similarly melted or welded on the ground. The power source of the melting was an electron beam unit. Results are presented which support the concept that the major difference between ground-base and Skylab samples (i.e., large elongated grains in ground base samples versus nearly equiaxed and equal sized grains in Skylab samples) can be explained on the basis of constitutional supercooling, and not on the basis of surface phenomena. Microstructural observations on the weld samples and present explanations for some of these observations are examined. In particular, ripples and their implications to weld solidification were studied. Evidence of pronounced copper segregation in the Skylab A1 weld samples, and the tantalum samples studied, indicates a weld microhardness (and hence strength) that is uniformly higher than the ground base results, a finding which is in agreement with previous predictions. Photographs are shown of the microstructure of the various alloys.

41758 (PB—256057) **Metallurgical factors controlling weld metal toughness in the seam welding of line pipe.** Garland, J.G.; Kirkwood, P.R. (British Steel Corp., Sheffield). Jun 1976. 45p. (GS/PROD—832/1/76/C). NTIS $4.00.

The importance of the microalloying elements columbium and vanadium in controlling the toughness of submerged arc weld metal in seam welded microalloyed line pipe has been discussed. The role of excess vanadium in promoting low energy intergranular fracture in the Charpy-V-notch impact test has been highlighted. The shortcomings of commercially available C—Mn and C—Mn—Mo electrodes with respect to weld metal toughness have been demonstrated. A means of overcoming this problem by the use of a C—Mn—Ti—Mo—B electrode with a fully basic flux suitable for high speed DC/AC line pipe welding has been outlined, and the metallurgical background is described. Higher plate microalloying has been found to pose serious weld metal toughness problems. These cannot be fully overcome, but compositional modifications are currently being studied which offer the prospect of significantly improved properties in this area. (GRA)

41759 **Sputter-deposition of metastable Ta-Pu, Ag-Pu and Co-Pu alloys.** Allen, R.P.; Dahlgren, S.D.; Wang, R. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). pp 61-69 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

High-rate sputter-deposition techniques were successfully used to prepare supersaturated solid solution alloys for the normally immiscible Ta-Pu and Ag-Pu systems and to investigate the effect of substituting Pu for the rare-earth element in sputtered amorphous Co-Sm alloys. Two Ta-8 at.%Pu deposits were prepared and both exibited a unique two-phase bcc α-Ta and tetragonal β-Ta structure. Both phases formed a metastable solid solution with the Pu resulting in a 0.85% increase in the α-Ta a parameter and a 1.5% increase in the β-Ta c parameter. The metastable β-Ta solid solution decomposed at a significantly lower temperature ($<$825 K) than the α-Ta solid solution (975 K). Efforts to prepare a Ag-Pu solid solution at room temperature were unsuccessful, but a Ag-0.5 at.% Pu solid solution was obtained by co-sputtering the elements onto a liquid nitrogen cooled subtrate. The solid solution was retained to room temperature for x-ray diffraction studies. The lattice parameter of the Ag was expanded from 4.086 A to 4.091 A, representing a positive deviation from Vegard's law. A Co-11 at.% Pu alloy (Pu_2Co_{17}) was sputter-deposited at 290 K for comparison with sputtered amorphous Sm_2Co_{17}. The x-ray pattern for the as-sputtered Co-Pu alloy exhibited the same type of broad, diffuse x-ray pattern as the Co-Sm deposit, but the position of the major peak was displaced from a d-spacing of 2.05 A to 2.34 A indicating a fundamental difference in atomic arrangement.

41760 **Splat cooling of some actinide alloys.** Elliott, R.O. (Los Alamos Scientific Lab., N.Mex. (USA)); Giessen, B.C. (Northeastern Univ., Boston, Mass. (USA)). pp 47-60 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

Several new metastable actinide alloys have been produced by rapidly quenching small specimens from the melt. Among these are: (1) the high temperature b.c.c. phases of Pu (epsilon-phase) and Np (γ-phase) which have been retained at room temperature by splat cooling alloys with Ti or Ga, (2) ete-Pu(Ga), an ordered cubic phase of the substoichiometric CsCl type; this phase exists under equilibrium conditions at high temperatures over the composition range from about 20 to 40 at. % Ga; its previously unknown structure was determined from the diffraction patterns of splat-cooled alloys, (3) $delta_1$-Pu(Ga), a tetragonal phase of the β-Np type containing 12.5 to 20 at. % Ga and (4) a continuous series of f.c.c. solid solutions across the 'solubility gap' in the Pu-Ce system. Metastable delta-Pu(Ti) and delta-Pu(Ga) solid solutions were produced at 20°C in alloys containing about 25 at.% or less of Ti or Ga, and a metastable α-Np(Ga) solid solution was produced in alloys with less than 10 at. % Ga. These new actinide alloy phases are reviewed and the anomalous increase in atomic volumes of α-Np(Ga), γ-Np(Ga) and epsilon-Pu(Ga) concentrated solid solutions with increasing Ga content is discussed.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 42209

41761 **Microstructure and kinetics of the plutonium βyieldsα and γyieldsα transformations.** Allen, R.P.; Arrowsmith, H.W. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). pp 775-785 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

Supported-discharge cathodic etching and SEM examination techniques were developed for α-Pu and used to investigate the α microstructures formed by the $\beta\alpha$yieldsα and $\beta\gamma$yieldsα transformations in high-purity extruded Pu at low and high α-phase temperatures ($\beta\alpha$ and $\beta\gamma$ are β formed from α and γ, respectively). Low (200 K) $\beta\alpha$yieldsα transformation temperatures produced α with a grain size that was finer than that of the original extruded α and substantially smaller than the grain size of the α formed from $\beta\gamma$. At high α-phase temperatures (343 K to 370 K), $\beta\alpha$ transformed to α by the surface nucleation and inward growth of colonies of columnar α grains oriented radially with respect to the original nucleation site. The transformation kinematics could be correlated with the microstructural observations based on a correspondence between the long axes of the grains and the [010] direction of the monoclinic α-Pu structure. Significant changes in the size, shape, and orientation of the α grains were noted with increasing transformation temperature. Conversely, the grain size of the α formed from $\beta\gamma$ was essentially constant at all transformation temperatures. Metallographic evidence of the γyieldsα skip transformation or a significant change in the mode of the γyieldsα transformation was obtained by a comparison of the α microstructures produced by quenching γ to high (362 K to 368 K) and low (200 K) α- phase temperatures.

41762 **de Haas-van Alphen effect in URh_3 and UIr_3.** Arko, A.J.; Brodsky, M.B.; Crabtree, G.W.; Karim, D.; Windmiller, L.R.; Ketterson, J.B. (Argonne National Lab., Ill. (USA)). pp 325-336 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam; North-holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

Measurements of the deHaas-vanAlphen effect have been performed in the intermetallic compounds URh_3 and UIr_3. Complex spectra are observed in both materials. Effective mass measurements were made for several orbits in URh_3 and values as large as 5.3msub(o) were observed. The relatively complete data in URh_3 are consistent with a complex multiply-connected Fermi surface which is in qualititative agreement with band structure calculations. The largest frequency branches in UIr_3 appear to have the same topology as their corresponding branches in URh_3. In addition, a number of closed low-mass surfaces exist in UIr_3 and are discussed in terms of the calculations for URh_3.

41763 **Analysis of the α-Pu 5f electron distribution by X-ray emission spectroscopy.** Bonnelle, C.; Lachere, G. (Paris-6 Univ., 75

(France). Lab. de Chimie Physique). pp 337-341 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The 5f distribution of α-plutonium has been analysed by X-ray emission spectroscopy. Transitions $3d^{10}$ 5fsup(n) from $3d^{9}$ 5fsup(n+1) have been observed in coincidence with one structure in the absorption spectrum. Information on the relaxation processes in the solid is deduced. The position of 5fsup(n) states with respect to Fermi level is given.

41764 Study of the modification of the 5f states in the α and delta-plutonium phases by X-ray absorption spectroscopy. Bonnelle, C. (Paris-6 Univ., 75 (France). Lab. de Chimie Physique); Courtois, A.; Calais, D. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France)). pp 343-349 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

An analysis of the Msub(IV-V) plutonium absorption spectra has shown an electronic structure modification between the α and delta phases : this is due to an increase of the 5f atomic states number in delta-Pu. These results are in agreement with a suggestion proposed by J.Friedel according to whom the 5f electrons are much more localized around each ion in the high temperature plutonium phases than in α-Pu. They experimentally corroborate the atomic volume expansion between α and delta phases being connected to an increase in the number of localized electrons, the latter screening the nuclear charge. Conversely, any atomic volume contraction must be followed by the opposite electronic modification, therefore by a 5f electron delocalization towards the 6d or 7s states. The experiment enabled the authors to check indirectly that a 5fyields6d promotion must occur at the deltayieldsepsilon and epsilonyields liquid transformations since these take place with a volume contraction. It confirms the activated self interstitial model which has been proposed to explain the anomalous self-diffusion observed for epsilon plutonium and for cerium.

41765 Some results of a study of the Pu-Al-Ga phase diagram. Chebotarev, N.T.; Smotriskaya, E.S.; Adrianov, M.A.; Kostyuk, O.E. (All-Union Scientific Research Institute of Inorganic Materials, Moscow, USSR). pp 37-46 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The results are reported of the study into a delta-solid solution range, $PuAl_2$-$PuGa_2$ quasi-binary section and $PuAl_3$-$PuGa_3$ and $PuAl_4$-$PuGa_4$ polythermal sections for the ternary system Pd-Al-Ga. The results are also given of the study into a binary system Pu-Ga.

41766 Crystal structure of the compounds Pu_6X_4 (X=Rh, Ir). Chebotarev, N.T.; Beznosikova, A.V. (All-Union Scientific Research Institute of Inorganic Materials, Moscow, USSR). pp 115-119 of In Plutonium 1975 and other acinides. Blank, H.; Lindner, R. (eds.). Amsterdam; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The structure of the intermediate phases Pu_6X_4 (X=Rh, Ir) was determined from X-ray examinations of single crystals. The compounds of Pu_6Rh_4 and Pu_6Ir_4 are isostructural with the orthorhombic lattice space group Pnma, z=4. The lattice spacings, the atom position, the atomic parameters and the theoretical density of the compounds are listed, and the interatomic distances and the atom co-ordination are given.

41767 Metallurgical properties of metallic alloys in relation to their electronic structure: theoretical aspects and prospective for actinides. Duncastelle, F. (Office National d'Etudes et de Recherches Aerospatiales (ONERA), 92 - Chatillon (France)). pp 21-35 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

A method for calculating energies (energies of formation, ordering energies,...) in transition metals and alloys is described. The d band states are treated in the tight-binding approximation and the coherent potential approximation is used to deal with concentrated disordered alloys. Then the possibility of applying similar techniques to the case of actinides is discussed.

41768 βyieldsα phase transformation in unalloyed plutonium after full and partial β phase formation. Faiers, M.E. (UKAEA Weapons Group, Aldermaston. Atomic Weapons Research Establishment). pp 739-748 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

Experiments have been performed to compare the βyieldsα transformation kinetics in unalloyed plutonium after the formation by fission heating of 100% β phase and after partial β phase formation. The results obtained from this work indicate that the βyieldsα kinetics after the formation of 100%β phase are very similar to those previously reported. However, after partial formation of the β phase the βyieldsα kinetics are markedly altered, the transformation beginning very rapidly, occuring at temperatures in excess of those predicted from the previously published data, and the rate of transformation also being much greater than predicted.

41769 Localized vs itinerant 5f electrons: a review of the experimental evidence. Fradin, F.Y. (Argonne National Lab., Ill. (USA)). pp 459-474 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The question of localized versus itinerant character of the 5f electron states in the actinide metals and metallic compounds is discussed. The 5f states can form true bound states, resonance states within a broad conduction band, or narrow conduction bands depending on the details of the solid state environment. Various experimental probes project information out of the 5f state that is weighted to either the region near the actinide core in the interstitial regions between the cores. It is information about the electronic character in the outer regions that is most helpful in detailing the degree of delocalization of the 5f wave function. A review of the experimental information on the early actinide metals U, Np, and Pu as well as selected actinide intermetallic compounds is presented. Emphasis is placed on the discussion of the temperature dependence of the magnetic susceptibility, electronic heat capacity, electrical resistivity, and nuclear magnetic resonance experiments. The results of these experiments are influenced by details of structure in the electronic density of states near the Fermi level as well as by the nature of the generalized dynamic susceptibility. Descriptions of the actinide 5f states in terms of either localized, paramagnon, or itinerant models are considered.

41770 Hyperfine interactions in Np Pdsub(3-x)Rhsub(x). Gal, J.; Kroup, M.; Hadari, Z. (Israel Atomic Energy Commission, Beersheba. Nuclear Research Center-Negev). pp 659 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

Moessbauer experiments have been performed on the NpPdsub(3-x)Rhsub(x) (x=0.1, 0.25, 0.3) cubic system. The results show a decrease of the ordering temperatures for larger x with drastic increase in the hyperfine fields at the Np nucleus (from 3.3 Moe to 4.8 Moe).

41771 Effect of spin fluctuations in actinide systems. Jullien, R.; Coqblin, B. (Paris-11 Univ., 91 - Orsay (France). Lab. de Physique des Solides). pp 425-448 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The effect of ferromagnetic or antiferromagnetic like spin fluctuations is described in a model which takes into account the temperature dependence of the Stoner susceptibility and the applications of the model of different properties (electrical resistivity, magnetic susceptibility, thermal conductivity, nuclear relaxation rate ....) is discussed for actinide systems.

41772 Electronic energy band structure of actinide metals and intermetallics. Koelling, D.D.; Freeman, A.J. (Argonne National Lab., Ill. (USA)). pp 291-309 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The behaviour of the 5f electrons as the crucial factor in determining the electronic properties of materials containing actinides is discussed. Whether these electrons will be localized or itinerant depends on the relative size of the Coulomb correlations and the near-neighbour interaction (bandwidth) terms. Evidence from optical reflectivity and de Haas-van Alphen measurements is examined which shows that the f-states are itinerant in the light actinide metals. The mechanisms by which this occurs are examined and it is shown that the dominant feature is a direct f-f interaction on neighboring sites. It is as a result of this dominance that correlations with actinide separation are found for the observed superconducting and magnetic properties. Since materials which appear as exceptions to this correlation are significant as systems where the direct f-f interaction is not the dominant term, the $L1_2$ crystal structure materials involving uranium are discussed. The materials considered in detail are URh_3 for which an experimental determination of the Fermi surface has been made. In these systems, the dominant interaction is found to be the formation of a d-f bond.

41773 Role of lattice vibrations in the determination of the physical properties of the actinides. Long, K.A. (Surrey Univ., Guildford (UK)). pp 311-323 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The article examines the role of phonons, both optical and acoustic, in the actinide metals. It is pointed out that the complicated crystal structures imply that optical phonon branches exist in the actinide metals. These branches lie at relatively low frequencies, low enough for them to contribute to the low temperature electrical resistance, and to other transport properties. It is also suggested that strong electron-phonon interactions should modify the phonon spectrum, and this would explain the anomalies in the physical properties of uranium, plutonium and americium. In plutonium it is proposed that there are two temperature regimes. The first below 100K, is that in which plutonium behaves as a metal, and where conduction is metallic in nature. In this regime the electrical resistance is due to electron-phonon scattering, mainly by optical phonons. The second regime above 100K, is more akin to an amorphous or non-crystalline material, than to a metal, due to the disorder caused by the lattice vibrations. In this regime conduction is due to hopping by small polarons and by diffusion of electrons. Here the interactions are so strong that plutonium cannot be described by a band model. The thermal conductivity, the thermoelectric power, and the Hall effect are also discussed within this two regime model.

41774 Kinetics of the delta to alpha transformation in plutonium rich Pu-Ga alloys. Orme, J.T.; Faiers, M.E.; Ward, B.J. (UKAEA Weapons Group, Aldermaston. Atomic Weapons Research Establishment). pp 761-773 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

Resistivity and dilatometric measuring techniques have been employed to determine the kinetics of the deltayieldsα transformation in a series of Pu-Ga alloys containing 0.17 a/o-1.9 a/o Ga, over the temperature range +60°C to -155°C. The effect of increased Ga content was to 1. Depress the TTT curves to lower temperatures. 2. Displace the TTT curves to longer times. 3. Produce double 'c' curve characteristics in the 1.4 and 1.9 a/o alloys. The results are discussed and metallographic evidence which indicates that the deltayieldsα transformation may occur by a massive transformation under certain conditions and a martensitic transformation under other conditions.

41775 Kinetics of the βyieldsα transformation in unalloyed plutonium after partial formation of the β phase. Robinson, A.C.; Stacey, R.J. (UKAEA Weapons Group, Aldermaston. Atomic Weapons Research Establishment). pp 749-760 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The kinetics of the isothermal βyieldsα transformation after complete and only partial formation of the β phase in unalloyed plutonium containing about 900 ppm of impurity are reported and compared with previously published and conventionally accepted βyieldsα transformation kinetics after complete formation of the β phase in this material. In these experiments the heating was provided by constant temperature oil baths and the transformations were monitored by electrical resistance measurements on 0.63 mm diameter wire samples at temperatures ranging from -65°C to +75°C. After complete formation of the β phase in the plutonium used in these experiments the kinetics of the βyieldsα transformation were in general agreement with previously published data, although the present transformations were slower than reported by previous workers. After only partial formation of the β phase the subsequent βyieldsα transformations were found to be very fast and to be characterised by zero or very short incubation periods, rapid rates of transformation and a final equilibrium consisting of more than 90% β phase.

41776 Shear martensitic transformation in uranium alloys during quenching, plastic deformation and low temperature annealing. Sophronova, R.M.; Ivanov, O.S. (AN SSSR, Moscow. Inst. Metallurgii). pp 727-738 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The structure of quenched binary and ternary uranium alloys containing molybdenum, niobium and zirconium and effects of various thermal and mechanical treatments on the shear transformation in quenched alloys have been studied. Introduction of zirconium into binary alloys U-Mo and U-Nb led to the formation of the structures of the γ^0 and (αsub(b))″ phases and to the appearance of the (αsub(b))″ phase for values of the lattice parameter b in the range b<=5.84 A. Plastic deformation of quenched alloys produced the transformation γyields(αsub(b))″ at all steps, especially in alloys with the γ^0 and (αsub(b))″ structure near the boundary of these phases. The annealing at 100 - 300°C of alloys containing molybdenum or niobium as major addition leads to a reverse shear transformation. The annealing of alloys containing mainly zirconium leads to a more direct transformation. In some ternary alloys a more complex transformation was observed, a reverse motion at 100 to 200°C was changed into a direct one at 200 - 300°C. There is a correlation between the degree of transformation and cooling rate and the atomic motions associated with the transformation during annealing and the Msub(s) temperatures. The effect of quenching stress is considered as one of the reasons for this correlation.

41777 Model for liquid uranium and plutonium with implications on the adjacent solid phases. Wittenberg, L.J. (Monsanto Research Corp., Miamisburg, Ohio (USA)). pp 71-84 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The hard-sphere model for liquid metals, which is used to analyze the physical properties of liquid uranium and plutonium, predicted successfully only the compressibility of liquid plutonium while it underestimated the measured viscosity and surface tension values. Based upon a correlation with the rare earth elements, the heat capacities of liquid uranium and plutonium were smaller and their heats of vaporization were larger than predicted. All these deviations suggest additional attractive energy in these two liquids. Diffusion and positron annihilation experiments suggest the appearance of liquid-like clusters in the bcc phases that exist in equilibrium with these liquids. The elastic modulus of epsilon-Pu without these clusters was calculated to be approximately five times larger than the measured modulus.

41778 Melting-diffusion correlation in the plutonium-zirconium alloys. Zanghi, J.P.; Calais, D. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France)). pp 525-533 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The activation volumes for self-diffusion of Pu in b.c.c. PuZr alloys (10 and 40 at % Zr) have been determined, in order to check the validity of Nachtieb's melting-diffusion correlation. Indeed, in the Pu-40 at % Zr alloy, which has a pressure temperature phase diagram whose liquidus has a positive slope, a positive activation volume was found, whereas in pure epsilonPu where the slope is negative, the activation volume is negative. A self-diffusion mechanism in PuZr alloys is proposed.

41779 Some actinides double orthovanadates and orthoarsenates: structural 'evolution' due to cationic and anionic substitutions. Pages, M. (Paris-5 Univ., 75 (France)); Freundlich, W. (Laboratoire de Chime Minerale, 4, Place Jussieu 75005, Paris, France). pp 205-207 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The double orthovanadates M $A_3(VO_4)_3$ and M′ $A(VO_4)_2$ ($M=Li^+$, Na^+, Ag^+; $M'=Cd^{2+}$, Ca^{2+}, Pb^{2+} ; $A=Np^{4+}$, Pu^{4+}) and the soluble orthoarsenates $MA_3(AsO_4)_3$ ($M=Li^+$, Na^+; $A=Th$, Np^{4+}, Pu^{4+}) have been identified. They crystallize in three structural types: zircon, scheelite and monoclinic of a new type. On the other hand, the progressive substitution of As for V in the $MA_3(VO_4)_3$ phases ($M=Li^+$, Na^+) gives rise to a continuous disorder yields order transition.

41780 Magnetic phase transitions in UO_2 and uranium compounds with crystal structures of Th_3P_4-type. Przystawa, J.; Cracknell, A.P. (Dundee Univ. (UK). Carnegie Lab. of Physics). pp 609-617 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

This paper is concerned with a thermodynamical examination of the symmetry changes in some magnetic phase transitions; the arguments are based on Landau's theory of symmetry changes at second-order phase transitions. The general method is illustrated for some uranium compounds, namely the paramagnetic to antiferromagnetic transition in UO_2 and the paramagnetic to ferromagnetic transition in U_3X_4, where X=P, As, Sb, Bi, Se, and Te. It is shown that a simple antiferromagnetic transition in UO_2 may be understood as a second-order transition, but that if there is a weak ferromagnetic component it should be a first-order transition. For the U_3X_4 compounds the transitions are well understood as second-order transitions and a full discussion of the symmetry changes is given.

41781 Auger/loss studies of uranium, uranium oxidation, UO_2, U_3O_8, and UF_4. Ellis, W.P. (Los Alamos Scientific Lab., N.Mex. (USA)). *Surf. Sci.;* **61**: No. 1, 37-59(Dec 1976).

Auger/loss spectra were obtained from uranium metal free of detectable impurities in the α, β and γ phases. Loss excitations for the metal are in agreement with XPS levels of Fuggle et al. except for the O_4 loss peak which appears to couple to a transient state ca. 7.3 eV more energetic than in XPS. Good agreement is obtained with Auger spectra if experimental XPS valence bonding bands are used, and chemical shifts upon oxidation are accounted for accurately. Loss spectra for uranium compounds do not agree in general with XPS. Relaxation differences in the excited states appear to be the reason for this discrepancy. UO was identified as a stable surface compound on U metal under specific oxidizing conditions.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 40732, 41010, 41044, 41047, 41156, 41378

41782 (N—76-26287) **Tensile behavior of unnotched and notched tungsten—copper laminar composites.** Hoffman, C.A. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Jun 1976. 34p. (NASA-TN-D—8254; E—8069). NTIS $4.00.

Relations were studied between the tensile strengths of unnotched and of notched, and elastic moduli of unnotched laminar sheet or foil composites and the amounts of reinforcement. Tungsten was used as the reinforcement and copper as the matrix, and the tests were run at room temperature. Three thicknesses of tungsten (i.e., 0.00254, 0.0127, and 0.0254 cm (0.001, 0.005, and 0.010 in) were used, and the nominal volume fraction of tungsten was varied from about 0.05 to 0.95. It was found that the tensile strength of the unnotched specimens could be related to the amount of reinforcement, as could the elastic moduli, and that these values could be predicted by use of the rule of mixtures. The tensile strengths of the notched laminar composites could be predicted by use of the rule of mixtures using strengths for notched constituents, provided notch effects did not predominate. (Author) (GRA)

41783 (PB—257563) **Determining fracture properties of reactor vessel forging materials, weldments, and bolting materials. Final report.** Van Der Sluys, W.A.; Seeley, R.R.; Schwabe, J.E.; Lowe, A.L. Jr; Ayres, P.S. (Babcock and Wilcox Co., Alliance, Ohio (USA). Research Center). Jul 1976. 73p. NTIS $4.50.

A large testing program was initiated to evaluate heat-to-heat variability in fracture toughness of ferritic nuclear pressure vessel steels which are currently described by the reference toughness curve (KIR) relationship found in Appendix G, Sect. III of the ASME Boiler and Pressure Vessel Code. The program was established using a Task A Program Office to coordinate and administer testing procedures, data analysis, and data storage, and to perform a statistical analysis of the data. Three Task B testing laboratories were chosen to perform the fracture toughness testing. The results of the testing program, on project No. 232-3, are reported in EPRI reports NP-119 (Task B), RP 232-2, and this report. The initial statistical analysis of the data is reported in EPRI report NP-121 (Task A). (GRA)

41784 (PB—261996) **Semi-annual report on materials research in support of superconducting machinery. Final report.** Reed, R.P.; Hust, J.G.; Kasen, M.B.; Ledbetter, H.M.; McHenry, H.I. (National Bureau of Standards, Boulder, Colo. (USA)). Oct 1976. 322p. (NBSIR—76-848). NTIS A14.

Sponsored in part by Advanced Research Projects Agency, Arlington, Va. See also PB—252013.

The following five areas are discussed: advanced composites, elastic properties, fatigue resistance and fracture toughness, magnetothermal conductivity, and thermal conductivity. Material properties were studied over the temperature range 4 to 300°K. Materials studied include: aluminum alloy 5083, copper—0.3 cadmium—0.3 tin, copper—28 nickel, iron—48 nickel, 3.5 Ni and 9 Ni steels, titanium—4 aluminum—6 vanadium, titanium—5 aluminum—2.5 tin, stainless steel 21-6-9, several austenitic stainless steels of the 300 series, 300-grade maraging steel, phenolformaldehyde, and the composites boron/aluminum, boron/epoxy, graphite/epoxy, and niobium—titanium—titanium/copper.

41785 (N—76-28369) **Durability of tungsten—cobalt carbide alloys.** Shnyrev, P.D. Translated from Mashinovedeniye (USSR) *Mashinovedenie;* No. 1, 111-112(1974). 6p. (NASA-TT-F—16745). NTIS $3.50.

The relative durability of alloys with a differing content of cobalt and different average grain diameters of the tungsten was studied. In the former case, the cobalt content in the alloys changed from 4 to 20%. In the latter case, tests were conducted on alloys with 6% cobalt of very fine grained, fine, normal, and large grained series, with grain diameters of the carbide phase of 1.27, 2.0, 2.35, and 2.54 microns, respectively. The wear was determined in the form of volumetric wear, and the relative durability was determined as the ratio of the standard wear magnitude to the wear of the sample being studied with the same friction methods.

41786 Nonlinear compliance curves caused by crack closure in fracture tests of tungsten alloy. Beitscher, S. (Rockwell International, Atomics International Division, Rocky Flats Plant, Golden, CO 80401 (US)). *Eng. Fract. Mech.;* 8: No. 4, 749-751(1976).

This note describes unusual behaviour observed during fracture toughness measurements of a tungsten (97.4%), nickel, copper and iron alloy. Nonlinear elastic behavior was observed in the compact tension specimens after fatigue precracking. The specimens behaved elastically with a decreasing stiffness up to some low load, and then continued to deflect elastically but at a constant lesser stiffness until crack propagation started. An explanation of this behavior is given which is based on residual closure forces acting across the fatigue crack.

41787 Some rules in the strengthening of uranium alloys. Gromozov, L.I.; Lyutina, E.M.; Ivanov, O.S. (AN SSSR, Moscow. Inst. Metallurgii). pp 663-677 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The main factors are discussed which control the strength of uranium alloys at high temperatures in one-phase (γ-solid solution) and heterophase regions.

41788 Effect of strain rate on the tensile properties of α- and delta-stabilized plutonium. Hecker, S.S.; Morgan, J.R. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 697-709 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The tensile properties of unalloyed α-Pu and 3.4 at.% Ga-stabilized delta-Pu were determined at strain rates from 10^{-5} to 100/s. Tests at strain rates $< 10^{-2}$/s were conducted on an Instron Testing Machine; those at strain rates between 10^{-2} and 3/s on a closed-loop electrohydraulic MTS system; and those at strain rates greater than 3/s on a specially modified Charpy Impact Tester. Three lots of delta-Pu, one rolled and annealed and the other two cast and homogenized, were tested. The 0.2% yield strengths and ultimate tensile strengths increased by an average of 5.2 and 6.0 MPa per factor of 10 increase in strain rate. This increase was achieved without penalty in tensile ductility as measured by total elongation to fracture and by reduction in area. The isostatically pressed α-Pu specimens also showed a large increase in fracture stress with strain rate (34.3 MPa per factor to 10 increase in strain rate). The fracture was macroscopically brittle (plastic strains $< 0.3\%$) although extensive evidence of microscopic flow was observed in the ductile dimple-type appearance of the fracture surfaces. The strain to fracture appeared to exhibit a minimum at a strain rate of 10^{-2}/s.

41789 Sound velocity and elastic moduli in α-plutonium at pressures to 50 Kbar. Merz, M.D.; Hammer, J.H.; Kjarmo, H.E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). pp 567-571 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

Longitudinal and shear sound velocities were measured in α-plutonium at pressures to 50 kbar. The pressure derivatives were 14.3 and 4.3 m/sec/kbar, respectively. The elastic bulk and shear moduli were calculated and the average pressure derivatives were 14 and 3.5, respectively. Poisson's ratio increased from 0.17 at atmospheric pressure to 0.28 at 50 kbar.

41790 Mechanical properties of α-neptunium: hardness and elastic moduli. Merz, M.D.; Kjarmo, H.E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). pp 679-685 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The hardness of orthohombic α-neptunium was 418, 395 and 346 Dph at 203, 240 and 298 K, respectively. The high values of hardness were attributed to the high stresses required fpr deformation twinning in highly twinned grains. Deformation twinning always ocurred around the hardness indentations; slip was also observed. A second twinning mode in addition to the reported [110] mode was suggested by the observations. Shear and bulk moduli were measured from 77 to 373 K; the values at 298°K were 8.28 x 10^{11} and 117 x 10^{11} dyne/cm^2, respectively.

41791 Internal stresses in α-plutonium during deformation. Merz, M.D. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). pp

711-717 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

Internal stresses were measured in fine grained (2 μm) and coarse grained (20 μm) α-plutonium. In the fine grained metal the internal stress sigmasub(i), which was interpreted as the stress driving recovery processes near grain boundaries, was weakly dependent on applied stress, sigmasub(a). The effective stress, sigmasub(e) = sigma sub(a) - sigmasub(i), which is the stress to move dislocations, increased nearly 1:1 with applied stress, especially at high applied stresses. The strain rate obeyed the relation epsilon=K(T)sigmasub(e)sup(n) where K(T) is a temperature dependent term and n approximately = 3. The recovery rate in fine grained α-plutonium during creep was concluded to be very sensitive to internal stress. The internal stress in α-plutonium with 20 μm grain size was much higher than in the finer grain metal.

41792 Single-crystal elastic constants of a plutonium-gallium alloy. Moment, R.L. (Rockwell International, Atomics International Division, Rocky Flats Plant, Golden, Colorado, USA). pp 687-696 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The single-crystal elastic constants of a plutonium-1 wt % gallium alloy were determined at room temperature by measuring ultrasonic sound-wave velocities. The three independent elastic constants of this face-centered cubic delta-phase alloy were determined from the longitudinal and the two shear-wave velocities, all along a <110< direction. Their values are $C_{11}=3.628$, $C_{12}=2.673$ and $C_{44}=3.359$ in units of $10^{10}N/m^2$; the respective errors are estimated to be 1%, 1%, and 0.3 %. The Zener anisotropy ratio is 7.03, almost twice that known for any other fcc metal, and falls among the ratios for the body centered cubic alkali metals, which are noted for their high elastic anisotropy. Polycrystalline elastic constants calculated from the single-crystal data are Young's modulus E=4.064, the shear modulus G=1.596 and the bulk modulus (reciprocal compressibility) B=2.991, all in units of $10^{10}N/m^2$, and Poisson's ratio $\gamma=0.27$. These values of E and G are both lower than those obtained by Taylor, Linford and Dean from measurements on polycrystalline specimens. Within a single crystal, the longitudinal sound velocity varies with direction by a factor of 1.4 and the transverse velocity by a factor of 2.6. The maximum Young's modulus (along <111<) was 5.4 times larger than the minimum (along <100<). The Debye temperature was calculated to be 105.7 K at 293 K and estimated to be 114 K at 0.K.

41793 Anomalous thermal property behaviour of uranium at low temperatures. Sandenshaw, T.A. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 487-499 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

Low temperature heat capacity curves are presented for polycrystalline ^{235}U and ^{238}U metals in different microstructural states and of different purities. Thermal conductivity versus temperature curves are shown for polycrystalline ^{238}U metal after undergoing varied fabrication procedures such as casting, swaging, γ-phase extrusion and α-phase rolling. Purity and the microstructure existing at the time of thermal property measurements appear to determine whether α-phase uranium is modified reversibly or irreversibly, if at all, on cooling below 250-270 K. It is suggested that the cooling rate through the βyieldsα phase transformation temperature of uranium has a considerable influence on observed low temperature properties because of the resulting defect (dislocation and stacking fault) structure. It is speculated that the reproducible heat capacity behaviour observed between 36 K and 250 K in a specimen of ^{238}U is due to a type of defect ordering which is compatible with a martensitic transformation.

41794 Creep and creep--rupture properties of $2^1/_4$Cr2Mo steel for fast breeder reactor in high temperature sodium. Yuhara, S.; Atumo, H. (Power React and Nucl Fuel Dev Corp, Ibaraki, Jpn). *Zairyo;* **25**: No. 270, 263-270(Mar 1976). (In Japanese with English abstract).

To provide a basis for designing structural components for the secondary sodium cooling system of a fast breeder reactor and for determining the optimum service conditions of these components, it was necessary to determine the creep and creep--rupture properties of $2^1/_4$Cr1Mo steel in sodium and also to clarify the effects of sodium corrosion on these properties. Creep and creep--rupture tests under uniaxial tension were made using specimens extracted from seamless tubes of normalized and temperated $2^1/_4$Cr1Mo steel of domestic heats at temperatures of 500, 550 and 600°C in flowing sodium with an oxygen level of 10 wppm. Similar tests were carried out at the same temperatures in air for the purpose of comparison. It was found that at 500 and 550°C, the values of the creep--rupture strength in flowing sodium and those in air were not significantly different. The rupture strength at 600°C, however, was significantly lower in the sodium environment than in air. The decrease in rupture strength became greater as the exposure time in sodium was increased. This apparent reduction in rupture strength was accompanied by a significant increase in carbon loss due to decarburization of the specimens tested. The creep--rupture strength in air at 550°C for the specimens after exposure to flowing sodium was found to decrease almost proportionally to the carbon loss in specimens of 0.10 to 0.03 wt%. The rate of average metal loss in $2^1/_4$Cr1Mo steel was calculated to be 1.2+-0.1 μm/year from the values of the weight loss after exposure to flowing sodium containing 10 wppm of oxygen from about 10,000 hr in the temperature range from 545 to 560°C.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 40944, 41001, 41003, 41551, 41784

41795 (AD-A—030791) **Rare Earth—transition metal magnetostrictive materials. Progress report.** (American Univ., Washington, D.C. Dept. of Physics). Jul 1976. Contract N00014-75-C-0736. 35p. NTIS, PC A03/MF A01.

There are three basic models of an amorphous ferromagnet. Gubanov suggested very early that the amorphous ferromagnet is characterized by a distribution of exchange interactions. This plausible assumption has been pursued by a number of groups. Another view is that the exchange is uniform, but that the large single ion anisotropy is distributed uniformly in directions of easy axis over the unit sphere. Still a third approach, the collective electron model, is one we introduced and continue to work on. It is probably the right model for amorphous nickel, an itinerant ferromagnet in its crystalline phase, but is surely not descriptive of the rare earths. For the rare earth alloys neither the exchange nor the crystal field models have been carried to such agreement with experiment as to exclude the other from consideration, and there may be room for the both models in describing different materials. The quadrupole splitting in an amorphous material is the same as it is in the crystalline phase. (GRA)

41796 (PNC-N—941-75-113) **Study of NaK flow and heat transfer, (1). Tabulation of the physical quantities of NaK.** Sakai, T.; Gunji, M.; Ikeda, T.; Ishida, T.; Iida, S. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Dec 1975. 33p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

NaK might be used as a primary coolant of the core catcher system, if necessary, of LMFBR "MONJU". From this point of view NaK flow and heat transfer test loop has been designed and is now under construction. The purposes of the test loop are to acquire the handling technique of NaK alloy, to examine such equipments as the electromagnetic pump, the electromagnetic flow meter, the plugging indicator and the cold trap. In this report, the information was gathered on the fundamental characteristics and physical quantities of NaK alloy prior to the construction of the test loop. The physical quantities of eutectic liquid NaK (Density, Viscosity, Kinematic viscosity, Specific heat, Thermal conductivity, Thermal diffusivity, Prandtl number, Electrical resistivity, Partial pressure of K, Partial pressure of Na, Saturated pressure of NaK, and Heat transfer number of pump) were calculated using the experimental or theoretical equations in the temperature range from -10 to 800°C at an interval of 10 degrees. The calculated physical properties are exhibited graphically. In the same figures, the properties of liquid Na are also indicated in order to show their differences between NaK and Na. The values of solubility of oxygen in NaK and the magnetic susceptibility were quoted from the published data.

41797 Thermodynamic properties of the binary Laves phase compounds of plutonium with the group VIIIa metals. Campbell, G.M. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 95-103 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The thermodynamic properties of $PuFe_2$, $PuRu_2$ and $PuOs_2$ were determined using fused salt e.m.f. cells. The data indicate that there is a regular correlation between the stability of these AB_2 Laves type compounds and their unalloyed atomic radius ratio. The limited amount of data available tend to support the conclusion that other Laves compounds grouped according to their electronic bonding structure show a similar correlation.

41798 Impurity diffusion of cobalt in plutonium. Charissoux, C.; Calais, D. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France)). pp 787-798 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The sectioning method for investigating impurity diffusion of ^{60}Co in the fcc and bcc phases of plutonium gave the following results: 344-426°C: $D = 1.2 \times 10^{-2} \exp(-12700/RT)$ cm² in delta Pu(fcc): 484-621°C : $D = 1.4 \times 10^{-3} \exp(-9900/RT)$ cm²/s in epsilon Pu (bcc). Cobalt is a fast diffuser in plutonium; the diffusion coefficient being unaffected by phase changes (delta'yieldsdelta ; delta' yields epsilon. The diffusion mechanism is probably dissociative in both phases, the solute becoming interstitial by : solute (substitution reversible solute (interstitial)+ vacancy.

41799 Itinerant magnetism in $NpFe_2Si_2$ and $NpCo_2Si_2$. Gal, J.; Kroup, M.; Hadari, Z.; Nowik, I. (Israel Atomic Energy Commission, Beersheba. Nuclear Research Center-Negev). pp 501 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The first observation is reported of two systems, $NpFe_2Si$ and $NpCo_2Si_2$, where the Np, Fe, Co show no localized moment, yet the systems become ordered at 87+-3 ($NpFe_2Si_2$) and 42+-3 K ($NpCo_2Si_2$). These results have been obtained by performing Moessbauer effect studies of the 59.5 keV transition of Np^{237} and the 14.4 keV transition of Fe^{57} and magnetization measurements using a rotating sample magnetometer.

41800 Heat transport properties of a delta-stabilized Pu-1 wt.% Ga alloy from room temperature to 500 degrees C. Kruger, O.L. (Exxon Nuclear Co., Richland, Wash. (USA)); Robbins, J.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). pp 547-557 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

Measurements of the thermal diffusivity of a Pu-1 Wt. % Ga alloy were obtained over the temperature range of 25 to about 600° C. Experimental points were fitted by a least squares technique through the use of a computer program to the expression $\alpha = 3.545 \times 10^{-2} + 6.08 \times 10^{-5}$ T. These data were subsequently combined with existing heat capacity values to derive a curve of thermal conductivity as a function of temperature. According to this work, the thermal conductivity of the delta-stabilized plutonium increases from 0.0190 cal sec^{-1} cm^{-1} C^{-1} at room temperature to 0.0458 cal sec^{-1} cm^{-1} C^{-1} at 500° C. Analysis of the data, based on calculations of the electronic contribution, supports the experimental results and shows that the thermal conductivity of delta-stabilized plutonium follows classical behavior for good thermal conductors.

41801 Alloying, radiation damage, and Matthiessen's rule in plutonium. Long, K.A. (Surrey Univ., Guildford (UK)). pp 449-457 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

Experimental results on the additional resistance due to self radiation damage in plutonium, and on the resistance of PuNp alloys are discussed. An explanation is given in terms of resonant scattering, from defects in the first case, and from neptunium atoms in the second case, both within the Slater-Koster model. In the latter case it is found necessary to introduce local spin fluctuations on the neptunium atoms, combining this with the resonant scattering on the neptunium atoms. The variation of the resistance of plutonium with temperature and the deviations from Matthiessens rule in plutonium are discussed in the light of these results.

41802 Heat of formation of plutonium alloys. Miedema, A.R. (Philips Gloeilampenfabrieken N.V., Eindhoven (Netherlands)). pp 3-20 of In Plutnium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

In a series of papers Miedema, de Boer and Boom have demonstrated that a simple atomic model can account quantitatively for the heat of formation, ΔH, of liquid as well as solid alloys. An alloy is suggested to be constructed from Wigner-Seitz atomic cells similar to those in pure metallic elements. Then the alloying energy originates from the change in boundary conditions when dissimilar atoms come into contact. It has been claimed that, by means of the model description, heats of formation of binary intermetallic compounds which contain at least one transition metal can be predicted with an accuracy that is comparable with that of experimentally determined values. In the present paper the model is used to calculate the enthalpy of formation of binary alloys that contain plutonium. Predicted values of ΔH are tabulated for all known metallic Pu-compounds. Since there are only few experimental data on ΔH the correlation between the predictions and the general appearance of the binary phase diagrams Pu-X is discussed (i.e. the number of compounds that occur, solid solubilities).

41803 Investigation of some magnetic and electric properties of compounds in the U-Ga system and of the U_3As_4 compound. Sechovsky, V.; Smetana, Z.; Menovsky, A. (Faculty of Mathematics and Physics, Prague, Czechoslovakia). pp 641-648 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The temperature dependence of the electrical resistivity, paramagnetic susceptibility and magnetization have been studied on the UGa (or U_2Ga_3) and UGa_2 compounds and are briefly discussed. The magnetic structure of UGa_2 is proposed on the basis of a neutron diffraction investigation. The possibility of noncollinear magnetic arrangement in the U_3As_4 compound is analysed by means of a neutron diffraction investigation and magnetization measurements performed on single crystals. The occurence of magnetic reflections in the paramagnetic state is shortly discussed as well.

41804 Magnetic ordering in the actinide intermetallics. Suski, W. (Polska Akademia Nauk, Wroclaw. Instytut Niskich Temperatur i Badan Strukturalnych). pp 621-634 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

140 refs.

To give a general idea about the progress achieved recently, the investigated materials, the used methods, and the observed phenomena - along with the respective references are listed for studies of magnetic transitions in actinide intermetallic compounds. In a more detailed way the most interesting or the most typical examples of the different types of magnetic ordering, and the most unusual phenomena observed recently are described.

41805 Thermoelectric properties of solid solutions based on uranium and thorium. Terechov, G.I.; Siniakova, S.I.; Tagirova, R.H.; Ivanov, O.S. (AN SSSR, Moscow. Inst. Metallurgii). pp 535-545 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The absolute thermoelectric power and resistivity of uranium alloys with zirconium, niobium, molybdenum, chromium, and of thorium alloys with yttrium have been studied in the state of solid solutions. The thermoelectric power of γ-solid solutions of uranium and molybdenum or chromium reach exceptionally high values for the metallic state: approximately 40μV/°C and more. Somewhat lower values of the thermal e.m.f. are to be observed for the U-Nb systems and still lower for the U-Zr system. The Th-Y alloys based on thorium have a thermal e.m.f. of an ordinary magnitude and a negative sign. The high values of the absolute thermoelectric power with positive sign can be explained approximately by the favourable combination of the derivatives of the Fermi surface and the density of states with respect to energy and to a strong interaction between the Fermi surface and borders of the Brillouin zones. The observed small temperature coefficients of resistivity of most γ-solid solutions can be explained by the compensation of the decrease of the mean free electron path as well as by the increase of the Fermi surface.

41806 Enthalpy and heat capacity of liquid plutonium and uranium. Thayer, W.L.; Robbins, J.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). pp 85-93 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The enthalpy and effective heat capacity of delta-plutonium and oralloy have been measured at temperatures high in the liquid region. The Super Kukla prompt-burst reactor was used to heat thin wafers of these metals by neutron-induced fission. The temperature increase in the samples was measured with thermocouples and the number of fissions in the sample determined radiochemically. From these data, heat capacity and enthalpy were calculated. The heat capacity of oralloy was calculated as 159 J/kg.°C up to 2200°C. A constant value of 180 J/Kg.°C was computed for the effective heat capacity of liquid delta-plutonium up to 2200°C. Because molten plutonium and uranium would chemically attack even the most refractory crucible materials, it would be very difficult to obtain such data by conventional laboratory calorimetry; it is believed that the use of neutron heating in these investigations is unique.

41807 Calorimetric study of the intermetallic compounds UAl_2 and $PuAl_2$. Trainor, R.J.; Brodsky, M.B.; Knapp, G.S. (Argonne National Lab., Ill. (USA)). pp 475-485 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The results of low temperature specific heat measurements on the strongly paramagnetic intermetallic compounds UAl_2 and Usub(0.3)Pusub(0.7)Al_2 in the temperature intervals 0.9-20K, respec-

tively are presented. These compounds are characterized by very narrow 5f bands near the Fermi energy. The low-temperature properties of UAl_2 and Usub(0.3)Pusub(0.7)Al_2 are dominated by long lived spin fluctuations within these narrow bands. In UAl_2 a nearly field-independent T^3logT contribution dominates the specific heat below 10K, consistent with the predictions of ferromagnetic spin-fluctuation theory. The specific heat, static susceptibility, and electrical resistivity are mutually consistent with Tsub(sf) = 25 +-10K, where Tsub(sf) is the characteristic spin-fluctuation temperature of the system. Below 20K, the specific heat of Usub(0.3)Pu(sub(0.7)Al_2 contains a very large linear term, C= 260T (mJ/mole-K), which is approximately four times the magnitude of the measured susceptibility, when both quantities are expressed in the same units. The specific heat of Usub(0.3)Pusub(0.7)Al_2 exhibits no anomalous behavior below 10K, where a resistivity anomaly has been previously observed. The properties of Usub(0.3)Pusub(0.7)Al_2 are quantatively discussed in terms of antiferromagnetic spin fluctuations.

41808 Inelastic neutron scattering studies of the phonon spectra of Chevrel phase superconductors. Bader, S.D. (Argonne National Lab., IL); Sinha, S.K.; Shelton, R.N. pp 209-221 of In Superconductivity in d- and f-band metals (1976). Douglass, D.H. (ed.). New York; Plenum Publishing Corp. (1976).

Phonon spectra are obtained using inelastic neutron scattering by polycrystals of the Chevrel-phase superconductors $SnMo_6S_8$, $PbMo_6S_8$, Mo_6Se_8, and $Pb_{1-x}Mo_6Se_8$. Modes associated primarily with Sn (or Pb) atomic displacements are clearly identified. Acoustic softening on cooling is noted for $SnMo_6S_8$. Anharmonicity and the superconductivity are discussed utilizing the molecular-crystal concept.

41809 Phonon anomalies in transition metals, alloys, and compounds. Smith, H.G.; Wakabayashi, N.; Mostoller, M. (Oak Ridge National Lab., TN). pp 223-249 of In Superconductivity in d- and f-band metals (1976). Douglass, D.H. (ed.). New York; Plenum Publishing Corp. (1976).

The anomalous features observed in the dispersion curves of several d-band superconducting materials are reviewed and comparisons are made with related non-superconducting materials. The results are briefly discussed in terms of some theoretical models. New neutron scattering data are presented for Nb with oxygen impurities, the Mo-Re bcc alloy system, and the hcp metals Tc and Ru.

41810 Gas anisotropy and T/sub c/ enhancement: general theory, and calculations for Nb, using Fermi surface harmonics. Butler, W.H. (Oak Ridge National Lab., TN); Allen, P.B. pp 73-120 of In Superconductivity in d- and f-band metals (1976). Douglass, D.H. (ed.). New York; Plenum Publishing Corp. (1976).

A general theory is given of the anisotropy of the energy gap and the resulting transition temperature (T/sub c/) enhancement of pure superconductors. The frequency dependence of the gap $\Delta(k,\omega)$ is approximated by the two square well form of McMillan, but otherwise an exact algebraic solution of the strong-coupling Eliashberg equations is given, valid for arbitrarily large anisotropy. In the limit of weak anisotropy a simple perturbative formula is also derived. The method of solution relies on the use of expansion functions called Fermi surface harmonics (FSH's) which are velocity polynomials orthonormalized on the Fermi surface. Methods for explicit construction of these functions are described. As an application of these techniques the mass enhancement and gap anisotropy are calculated for Nb, in an approximation which includes all electronic anisotropy but neglects the contribution to the anisotropy which arises from phonons. The rms gap anisotropy in this model is 6 percent which is not inconsistent with most of the current experimental data. The resulting T/sub c/ enhancement is predicted to be 0.7 percent or .06°K.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 40731, 41028, 41029, 41162, 41388, 41794

41811 (AD-A—034661) **Indexing the degree of hydrogen embrittlement of 4340 steel using the barnacle electrode. Progress report.** Berman, D.A. (Naval Air Development Center, Warminster, Pa. (USA). Air Vehicle Technology Dept.). 3 Nov 1976. 18p. (NADC—76359-30). NTIS, PC A02/MF A01.

The barnacle electrode, an electrochemical device based on the hydrogen permeation method, was used, in conjunction with sustained load tests, to index the degree of embrittlement of 4340 steel. Flat, double notched tensile specimens of 250 ksi (1725 MPa) notched tensile strength and having a K/sub T/ of 5.6 were shown to have a critical diffusible hydrogen concentration of 1.9, 1.7, 1.4, 1.2, 0.9 and 0.5 ppm for loads of 15, 20, 25, 30, 35 and 40 percent of the notched tensile strength.

41812 (AD-A—034723) **The role of passive film growth kinetics and properties in stress corrosion and crevice corrosion susceptibility. Technical summary report No. 7, Oct 1975—Nov 1976.** Kruger, J.; Ambrose, J.R. (National Bureau of Standards, Washington, D.C. (USA)). Nov 1976. Contract NAonr-18-69. 55p. (NBSIR—76-1170). NTIS, PC A04/MF A01.

See also report dated Oct 1975, AD-A—019648.

This report consists of four parts as follows: (1) A study of the influence of Mo in Fe-Mo alloys on crevice corrosion. It was found that <5% Mo is needed to affect repassivation in a crevice. (2) The description of a new technique for measuring repassivation rates in a crevice. (3) A description of alloys prepared to simulate the composition of metal near grain boundaries of sensitized austenitic stainless steel. These alloys are used for studies of the effect of sensitization on repassivation kinetics. (4) A review of new approaches in the study of localized corrosion.

41813 (EBO-P—673) **Corrosion in condensers and coolers of nuclear power due to cooling water.** Effertz, P.H.; Fichte, W.; Forchhammer, P. (Atomova Elektraren Bohunice, Jaslovske Bohunice (Czechoslovakia)). [nd]. 22p. (In Slovak). Dep. NTIS (US Sales Only), PC A02/MF A01.

Translated from German. Available from Atomova Elektraren, Jaslovske Bohunice, Czechoslovakia.

A survey is given of the principal causes of corrosion in nuclear power plant condensers and coolers. The possible mechanisms of the causes of deep local corrosion, the corrosion of cracks caused by the mechanical working of materials and of erosion corrosion are given for copper alloy pipes. Experience with the use of corrosion-resistant layers are given and recommendations made for the selection of suitable alloys, the application of corrosion-resistant layers and cleaning.

41814 (N—76-29370) **Coatings for directional eutectics. Final report.** Rairden, J.R.; Jackson, M.R. (General Electric Co., Schenectady, N.Y. (USA). Metallurgy Lab.). 25 Jul 1976. Contract NAS3-17815. 82p. (NASA-CR—135050; SRD—76-076). NTIS, PC A05/MF A01.

Significant advances have been made in the development of an environmentally stable coating for a very-high-strength, directionally solidified eutectic alloy designated NiTaC-13. Three duplex (two-layer) coatings survived 3,000 hours on a cyclic oxidation test (1,100 C to 90 C). These coatings were fabricated by first depositing a layer of NiCrAl(Y) by vacuum evaporation from an electron beam heated source, followed by depositing an aluminizing overlayer. The alloy after exposure with these coatings was denuded of carbide fibers at the substrate/coating interface. It was demonstrated that TaC fiber denudation can be greatly retarded by applying a carbon-bearing coating. The coating was applied by thermal spraying followed by aluminization. Specimens coated with NiCrAlCY+Al survived over 2,000 hours in the cyclic oxidation test with essentially no TaC denudation. Coating ductility was studied for coated and heat-treated bars, and stress rupture life at 871 C and 1,100 C was determined for coated and cycled bars.

41815 (NTIS/PS—77/0052) **Sea water corrosion. Volume 1. 1964—1975 (a bibliography with abstracts). Report for 1964—1975.** Smith, M.F. (National Technical Information Service, Springfield, Va. (USA)). Feb 1977. 213p. NTIS, PC N01/MF A01.

Corrosion of ships, oceanographic equipment, platforms, underwater vehicles, drill pipe, steel pilings and cables are covered in this report. Materials studied include steel and other alloys, concrete, composites and nuclear reactor components. (This updated bibliography contains 208 abstracts, none of which are new entries to the previous edition.)

41816 (PB—257 384) **Electrodeposition of titanium diboride coatings. Report of investigations 1976.** Schlain, D.; McCawley, F.X.; Smith, G.R. (Bureau of Mines, College Park, Md. (USA). College Park Metallurgy Research Center). Jul 1976. 28p. (BM-RI—8146). NTIS $4.00.

The report describes a method for electrodeposting titanium diboride from a molten salt bath. Initially, the electrolyte is a mixture of $LiBO_2$, $NaBO_2$, Na_2TiO_3, Li_2TiO_3, and TiO_2. The cell is operated at 900C in a dry, inert atmosphere with consumable anodes of titanium or hot-pressed titanium diboride (TiB_2) powder. Agitation of the electrolyte is essential. Current densities may be 6 to 9 amperes per square decimeter ($A/^2$ with titanium anodes and 9 to 30 $A/^2$ with titanium diboride anodes. A current density of 6 $A/^2$ is equivalent to a plating rate of about 35 micrometers per hour (μm/h). The adherence of the TiB_2 deposit varies with the substrate material. It is most adherent on molybdenum and on 4130 steel that has been preplated with copper and nickel, less adherent on nickel, and still less adherent on Inconel and on 4130 steel without the preplate. Cathode and anode reactions are suggested. (GRA)

41817 Importance of phosphate in the system iron/water. II. The chemistry of the system. Bohnsack, G. (Farbenfabriken Bayer A.G., Leverkusen (Germany, F.R.). Ingenieurbereich Energie). *VGB Kraftwerkstech.;* **56**: No. 10, 638-644(Nov 1976). (In German).

7 figs.; 24 refs.

A survey is given of the disadvantageous side-effects of phosphate charges on nuclear steam generators of pressurized-water reactors (pipes made of Inconel 600), on the corrosive chemical interaction of the phosphate ions with the materials, the role of the alkali, the difficulties in adjusting the pH and maintaining it in the case of enrichment, hide-out and chemical reactions with deposits or corrosion products. The authors then deal with the reaction between iron and phosphate. The problem of the corrosion of Fe is treated in three parts: 1) Influence of the phosphate on the primary process of anodic dissolution in active state; 2) the interaction of the phosphate with Fe ions in solution and 3) with corrosion products such as hydroxide, oxide hydrate and oxides, and influence on passive protective or cover layer construction.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 41936, 42315

41818 (AD-A—034885) **On the analogy between thermally and irradiation induced creep. Summary report.** Cozzarelli, F.A.; Huang, S. (State Univ. of New York, Buffalo (USA). Dept. of Engineering Science). Sep 1976. Contract N00014-75-C-0302. 31p. NTIS, PC A03/MF A01.

Employing an analogy between thermally induced and irradiation induced creep, physical arguments are used first to deduce a one-dimensional constitutive relation for metals under stress in a high temperature and high neutron flux field. This constitutive relation contains modified superposition integrals in which the temperature and flux dependence of the material parameters is included via the use of two reduced time scales; linear elastic, thermal expansion and swelling terms are also included. A systematic development based on thermodynamics, with the stress, temperature increment and defect density increment as independent variables in the Gibbs free energy, is then employed to obtain general three-dimensional memory integrals for strain; the entropy and coupled energy equation are also obtained. Modified superposition integrals similar to these previously obtained by physical argument are then obtained by substituting special functions into the results of the thermodynamic analysis, and the special case of an isotropic stress power law is examined in detail.

41819 (PNC-J—259-76-01) **Experimental study associated to irradiation of FBR structural material, (4).** (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). 28 Feb 1976. 91p. (In Japanese). Dep. NTIS (US Sales Only), PC A05/MF A01.

The study presents one of the bases to evaluate the results of the post-irradiation tests to conduct the thermal control tests related to the second JMTR irradiation (70M-61P) of the domestic austenitic stainless steels for the structural material of the FBR performed by Power Reactor and Nuclear Fuel Development Corporation. The thermal control specimens were given the temperature history which simulated that of the irradiation temperature in vacuum by the electrical furnance, and then the tensile, fatigue and Charpy impact tests were performed. The changes of the material properties caused by the thermal history were investigated.

41820 (VR—691/76) **Irradiation stability of welded joints.** Brumovsky, M.; Vacek, M. (Riecansky (V.E.) Technical Translations, Balsham, Cambridge (UK)). 1976. 8p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Translated from Zvaranie v. 25(3) 1976, p. 87-90. Available from V.E. Riecansky Technical Translations, Cambridge, price Pound4.00.

Results are presented of investigations into the neutron irradiation stability of welded joints in two types of steel used for reactor pressure vessels. Details are given of the materials used, method of welding and tests applied. The effect of irradiation on the notch toughness transition curve is shown. The results of the studies into irradiation embrittlement of all the welded joints and parent materials of the steels for the pressure vessels are summarized.

41821 **Relationship between structure and some properties of delta-Pu and γ-U alloys.** Chebotarev, N.T.; Utkina, O.N. (All-Union Scientific Research Institute of Inorganic Materials, Moscow, USSR). pp 559-566 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

Delta-plutonium, γ-uranium and alloys based on them have a number of anomalous properties not inherent in common metals and alloys. In addition to the properties known in the literature the paper discusses some other anomalous properties of these phases, in particular, an increase of the atomic volume as a result of cold working and prolonged room-temperature self-irradiation. A discussion is given as to the nature of the above phenomena. It is concluded that the anomalous properties of the phases considered result from the covalent component of the bond, that is due to the hybridization of the 5f and 6d levels and leads to a deviation of their structure from ideal fcc- and bcc-lattices.

41822 **Irradiation behaviour of UAlsub(x)-Al dispersion fuels for thermal high flux reactors.** Dienst, W.; Nazare, S.; Thuemmler, F. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung). *J. Nucl. Mater.;* **64**: No. 1, 1-13(Jan 1977).

UAl_3-Al and UAl_2-Al fuel plates (50 wt%UAl_3 or 45.5 and 54.5 wt%UAl_2, respectively, 220 mm x 40 mm x 1.3 mm) were irradiated in a pressurized water loop of the FR 2 (Karlsruhe). The maximum heat flux through the plate surface was about 100 W/cm², the surface temperatures between 70 and 185°C. The uranium burnups were 53 to 72% in the main series. The fuel swelling, the overheating behaviour and the irradiation-induced reaction of the fuel particles with the Al matrix were studied, the latter by quantitative image analysis, microprobe and microhardness measurements. The results show that Al-base dispersion fuels containing UAl_3 or UAl_2 are likewise suited for high burnups in research reactors. A uranium burnup of 40% is permissible in any case up to 180°C. For higher burnups up to 60%, UAl_2-Al fuel seems suitable without reservation, whereas in UAl_3-Al fuel plates there is a risk of heavy blister formation on overheating above 400°C. Above a burnup of 30 to 40%, fission product precipitation processes will strongly influence the behaviour. Below that limit the swelling observed was considerably lower than the value of about 6 vol%/10^{21} f/cm³ given in the literature. The reaction of UAl_3 and UAl_2 fuel particles with the Al matrix to Usub(1-x)Al_4 does not increase the volume percentage of the particles at high burnup, which took up to about 60 vol% for 55 wt% UAl_2.

CERAMICS, CERMETS, AND REFRACTORIES

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 41083, 41085, 41489

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 41088, 41839, 41858

41823 **Ab initio calculations of the crystal field splittings for Np^{3+} centers in CaF_2 (as well as for selected other complexes) by molecular orbital techniques.** Artman, J.O.; Wang, S.D.; Natarajan, A. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA). Dept. of Physics). pp 597-606 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The crystal potential splittings deduced for a number of actinide systems by a simple molecular orbital procedure are reported. Calculations have been performed for the following systems: (1) Np^{5+} in $CsNpF_6(5f^2)$, (2) Np^{4+}: ThO_2 ($5f^3$), (3) U^{3+}: $CaF_2(5f^3)$, and (4) Np^{3+} : CaF_2 (A,B and C sites) ($5f^4$).

41824 **Nuclear magnetic resonance of carbon 13 and nitrogen 15 in uranium and thorium carbonitrides.** Boutard, J.L. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France)); de Novion, C.H. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Section d'Etude des Solides Irradies). pp 505-514 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

Knight shifts and spin-lattice relaxation times have been measured on ^{13}C and ^{15}N in uranium and thorium rocksalt carbonitrides. Band character of 5f electrons is confirmed, at least in low nitrogen content uranium carbonitrides. The increase of magnetic susceptibility with nitrogen content in U(Csub(1-x)Nsub(x)) is shown to be due to an increase of spin susceptibility Stoner enhancement for $x < 0.5$. Thermally excited antiferromagnetic spin fluctuations are suggested. In U(Csub(0.4)Nsub(0.6)), the ^{13}C Knight shift is not so much temperature dependent as the bulk magnetic susceptibility is. The contributions to NMR linewidths are estimated.

41825 **Magnetic ordering and structural transformation in the actinide compounds.** Chan, S.K. (Max-Planck-Institut fuer Biophysikalische Chemie (Karl-Friedrich-Bonhoefer-Inst.), Goettingen (Germany, F.R.)). pp 575-588 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The problem of magnetic ordering in the actinide compounds with and without accompanying lattice deformation is discussed. It is suggested that magnetic ordering may be regarded as a selective process of condensation into modes of magnetization waves. Two types of ordering leading to magnetic stuctures that correspond respectively to intrinsic and accidental stationary free energy are

described. The possibilities of modulated structures and of the appearance of odd harmonics in certain types of orderings are examined. It is further suggested that magnetic ordering in the actinide compounds is in general coupled to the lattice vibrational modes because of the strong spin-orbit interaction and of the local orbitals of the 5f electrons. Exceptions to this are pointed out and summarized. When the coupling is nonzero, a magnetic ordering may trigger off a corresponding lattice deformation and be effected by the elastic properties of the crystal lattice. The possible types of lattice deformations and the various possible influences of the lattice modes on the magnetic transformation are summarized.

41826 Determination of oxygen potentials of hyperstoichiometric U-Pu dioxides in the temperature range 1500-1850 K. Chilton, G.R.; Kirkham, I.A. (UKAEA Reactor Group, Windscale. Reactor Development Labs.). pp 171-183 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

Oxygen potentials for Usub(0.85)Pusub(0.15) and Usub(0.69)Pusub(0.31) oxides have been measured at 1518, 1623 and 1823K using a transpiration technique. The results show that the oxygen potentials for the oxide become progressively less negative with increasing plutonium content over the temperature range used. Differences exist between extrapolation of previously published low temperature data and the results of this work.

41827 Some constitutional studies on uranium-carbon- and plutonium-carbon-rhenium and technetium systems. Haines, H.R.; Mardon, P.G.; Potter, P.E. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). pp 233-244 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

Some new experimental data on the phase diagrams U-Re-C, U-Te-C, Pu-Re-C, and Pu-Tc-C are presented. The data obtained for U-Re-C are in agreement with previous studies. The observations on the Tc systems confirm the formation of a Tc carbide with the upper limit of carbon content corresponding to the formula Tc_3C. In the U-Tc-C system, the $UTcC_2$ is present having an orthorhombic crystal structure, and is isomorphous with $UReC_2$. In the Pu-Re-C system there is no compound analogous to $UReC_2$, however, in this system and in the Pu-Tc-C system there is a ternary phase with a composition C ca. 30 at.%, and the Pu:Re or Tc ratio ca. 1.25. The Pu-Tc-C system is also characterised by a ternary compound PuTcsub(2-y) which has a monoclinic crystal structure. Tentative phase diagrams are presented for U-Re-C, and the Tc systems.

41828 Unified model for defects in substoichiometric plutonium dioxide and uranium plutonium mixed oxides. Manes, L.; Manes-Pozzi, B. (Commission of the European Communities, Karlsruhe (Germany, F.R.). European Inst. for Transuranium Elements). pp 145-163 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

A statistical model capable of treating, in a unified form, the known thermodynamic functions of PuO_2 and $(U,Pu)O_2$ in the substoichiometric region is described.

41829 Electronic properties of actinide oxides. Manes, L.; Naegele, J. (Commission of the European Communities, Karlsruhe (Germany, F.R.). European Inst. for Transuranium Elements). pp 361-382 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The available information of a direct nature on the properties of electrons in actinide oxides is critically surveyed. Some critical assessment is made on the new ideas about the bonding of these systems, ideas which have emerged mostly from thermodynamical and structural considerations. The aim in doing this is to a) judge how many of these ideas can be supported by direct experimental evidence on the electronic properties; b) attempt, on the other hand, to imagine which experimental results are needed to confirm or refute them.

41830 Low temperature lattice parameters of the actinide dioxides. Marples, J.A.C. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). pp 353-360 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The actinide dioxides all crystallise with the fluorite structure, space group Fm3m with four formula units per unit cell, and so form a well defined series. The low temperature lattice parameters of UO_2, NpO_2, PuO_2 and ThO_2 have been measured and the expansion coefficients have been derived.

41831 Thermodynamics of the uranium (α,β and γ-phases)-hydrogen system. Northrup, C.J.M. Jr. (Sandia Labs., Albuquerque, N.Mex. (USA)). pp 109-114 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

From measurements of solubilities, pressure-composition isotherms and the formation of crystal phases, Guinet proposed a complete phase diagram for the uranium-hydrogen system. At high pressures, he weighed his interpretation heavily on the the high temperature-high pressure measurements made by Chevallier Spitz and Blum. From these measurements he concluded that at lower pressures this system behaved as a peritectic. At higher pressures, Guinet indicated that existence of a continuous path between the γ-uranium and uranium hydride phases with a critical temperature of approximately 820°C and a corresponding eutectic behavior arising from the γ-uranium plus gas region. Recent measurements in this laboratory have shown that the critical temperature determined by Chevallier, Spitz and Blum was incorrect and that the lower temperature two phase regions extend to considerably higher pressures and temperatures than previously assumed. The phase diagram and some of the thermodynamic paramters for this system are discussed in the light of these new measurements.

41832 Study of atomic short-range order in nonstoichiometric actinide carbides by diffuse neutron scattering. de Novion, C.H. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Section d'Etude des Solides Irradies); Fender, B.E.F. (Oxford Univ. (UK). Inorganic Chemistry Lab.); Just, W. (Institut Max von Laue - Paul Langevin, 38 - Grenoble (France)). pp 893-902 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

Nonstoichiometric actinide rocksalt carbides and carbonitrides were investigated by diffuse neutron scattering. Repulsion between carbon vacancies was found in ThCsub(1-x), clustering in Npsub(1-x), and random distribution of C and N in U(Csub(1-x)Nsub(x)). Short-range order coefficients were obtained between first, second and third neighbours on the carbon sublattice for ThCsub(0.75):$\alpha_1 = -0.04$, $\alpha_2 = -0.30$, $\alpha_3 = +0.09$. The uranium sublattice is almost stoichiometric in U(C,N) but the thorium sublattice may show a few per cent vacancies in ThCsub(1-x).

41833 Some phase relationships and equilibria for the uranium-plutonium monocarbonitrides including the effects of oxygen on some equilibria. Potter, P.E. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). pp 211-232 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The phase equilibria of the binary U-C, PuC, U-N, and Pu-N appropriate to the consideration of the U-Pu carbonitride systems are firstly discussed. Some of the experimental data on the U-C-N and Pu-C-N phase diagrams are discussed in terms of ideal solid solution models for the monocarbonitride phase. This model is extended to describe some equilibria in selected regions of the U-Pu-C-N and U-Pu-C-N-O systems.

41834 New phases in curium-oxygen system. Sudakov, L.V.; Kapshukov, I.I.; Shimbarev, E.V.; Baranov, A.Yu. (The Scientific Research Institute of Atomic Reactors Named after V.I. Lenin, Dimitrovgrad, USSR). pp 185-190 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

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Taking previous observations and available literature into account a more detailed X-ray examination was made in the CmOsub(1.50)-(CmOsub(1.71) region by means of the anneal-quench experiments and high-temperature X-ray studies.

41835 Crystalline field and exchange interactions in the ternary uranium compounds of the U_2N_2M-type (M=P, As, S, Se). Zolnierek, Z.; Troc, R. (Polska Akademia Nauk, Wroclaw. Instytut Niskich Temperatur i Badan Strukturalnych). pp 589-596 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

New detailed susceptibility measurements have been carried out for all the U_2N_2M compounds in a wide temperature range (4.2-1000K). For all investigated compounds the $(xisub(M))^{-1}(T)$ func-

tion, in the range above Tsub(N), can be expressed as $(A/T + B)^{-1}$ +- lambda. The experimentally determined constants A,B, μsub(P) and μsub(AF) have been used in discussing the crystal field effect that occurs in these compounds. By applying both perturbative and nonperturbative calculations it was finally found that the crystal field parameters evaluated from the point-charge model are quite inaccurate to explain the experimental data. However, on the basis of magnetic and neutron diffraction measurements the ground state can be presumed to be a GAMMAsub3r doublet consisting of either (1+-4< ; 1-+2<) or (1+-4< ; 1+-1<) components and being well separated from the excited crystal-field levels. The problem of stability of various possible magnetic moment configurations in the hexagonal Ce_2O_2S-type structure has also been considered in detail using Bertaut's matrix method. The stability diagram of the magnetic phases occuring among the U_2N_2M ternaries is given.

MECHANICAL PROPERTIES

41836 Thermal creep of UO_2 and UO_2-PuO_2 in the stress range between 40 and 100 N/mm². Assmann, H. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). pp 833-842 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The transient creep of UO_2 and UO_2-PuO_2 can be described by dislocation kinetics. For the steady state creep an exponential creep region was discovered. The creep behaviour in this region can be interpreted by the jogged screw dislocation theory of high-temperature climb set forth by Barrett and Nix. The jog spacing lamdba increases with increasing temperature, according to an Arrhenius function, and is inversely proportional to the effective stress. Lambda decreases with increasing x in UOsub(2+x). The jog spacing is related to the effective activation volume Vsub(eff) by Vsub(eff) = lambda b^2, where b is the Burgers vector. Vsub(eff) governs the dependency of the steady creep rate on stress in the investigated range.

41837 Physical and mechanical properties of some uranium-containing carbides. Gomozov, L.I.; Dedjurin, A.J.; Titov, S.G.; Ivanov, O.S. (AN SSSR, Moscow. Inst. Metallurgii). pp 915-934 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The alloying of uranium carbides considerably deteriorates their nuclear characteristics. The change in physical and mechanical properties on formation of solid solutions of carbides, however, is of essential interest from the view-point of formulating rules for their strengthening. Properties of various uranium containing carbides are discussed.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 41837

41838 Fabrication and high temperature thermodynamic and transport properties of PuN. Alexander, C.A.; Clark, R.B.; Kruger, O.L. (Battelle Columbus Labs., Ohio (USA)); Robbins, J.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). pp 277-286 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976). (In German)

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Plutonium mononitride continues to be a potentially promising constituent nuclear fuel for the liquid metal fast-breeder reactor due to its high thermal conductivity and high melting point relative to other candidate fuels. A program was undertaken to measure thermodynamic properties of fuel at elevated temperatures: specifically, a pressure-composition diagram was generated for the plutonium-nitrogen system. Transport property measurements were also conducted as a function of sample density and temperature; thermal expansion measurements were made as were thermal diffusivity measurements. In the early stages of the program, it was necessary to spend significant effort developing sample fabrication techniques; this effort consisted of powder synthesis, hot pressing, and machining.

41839 Segregation and vapour pressure studies on the uranium-plutonium-carbon system. Browning, P.; Phillips, B.A.; Potter, P.E.; Rand, M.H. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). pp 257-265 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

Some experimental studies are reported on the segregation of U and Pu, and the plutonium vapour pressures, at 1400-1600°C, in the MC + M_2C_3(M= (U+Pu)) phase field in which mixed uranium-plutonium 'monocarbide' fuels normally lie. Comparison of the segregation results with calculations based on ideal solution behaviour in the MC and M_2C_3 phases suggests tha deviations from ideality are quite small. Vapour pressure measurements confirm this, indicating that any deviations are likely to be positive. Regular solution calculations and vapour pressure data are also reported for the phase fields containing graphite and sesquicarbide or dicarbide.

41840 Thermodynamic properties of (U,Pu)Osub(2+-x) described by a cluster model. de Franco, M.; Gatesoupe, J.P. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France)). pp 133-143 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

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A simple model is presented which allows the easy computation of ΔGO_2 and ΔHO_2, at any temperature and oxygen and plutonium content for UPuOsub(2+-x). Some implications on the nature of the defects are drawn, values for their energy of formation are given and their concentrations may be computed.

41841 Specific heat of PuCsub(1-x) and Pu_2C_3 from 10 to 300 K. McElroy, D.L. (Oak Ridge National Lab., Tenn. (USA)); Haines, H.R.; Hall, R.O.A.; Lee, J.A. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). pp 267-276 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The specific heat, Csub(p), of PuCsub(0.82), PuCsub(0.90), and PuCsub(1.51) was determined from 10 to 300K using adiabatic technique. Characterization of the arcmelted and heat-treated samples included chemical, X-ray and metallographic analyses. The Csub(p)-T values for PuCsub(0.82) and PuCsub(0.90) were accurate to +-1.3% and conclusively reveal anomalous Csub(p) behaviour below 150K where neutron diffraction has shown magnetic ordering to occur before rising in a normal manner to values of 46.06 $J.mol^{-1}K^{-1}$ (PuCsub(0.82)), which is 0.3% below the one literature value for PuCsub(0.81) and 47.92 (PuCsub(0.90) at 298.15K. The normal behaviour above 150K was fitted to better than 1% for both PuCsub(0.82), and PuCsub(0.90), by a simple Debye model, with a Debye temperature of 400K and electronic coefficients of 0.015 $J.mol^{-1}K^{-2}$ and 0.135 $J.mol^{-1}K^{-2}$, respectively. The difference between the calculated and measured curves below 150K show a basic Schottky transition for the PuCsub(0.82) with a superimposed lambda-type contribution in the case of PuCsub(0.90): i.e. the transition initiates as a nonco-operative excitation, becoming co-operative in its later stages.

41842 Optical properties of UO_2 and U_4O_9 single crystals and their relation to chemical bonding. Naegele, J.; Manes, L. (Commission of the European Communities, Karlsruhe (Germany, F.R.). European Inst. for Transuranium Elements); Birkholz, U. (Karlsruhe Univ. (TH) (Germany, F.R.). Inst. fuer Angewandte Physik). pp 393-408 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The measured near normal incidence reflectivities of UO_2 and U_4O_9 single crystals up to 10 eV have been analysed by a modified Kramers-Kronig analysis which accounts for the rise of the reflectivity at the experimental cut-off. The dielectric functions for both UO_2 and U_4O_9 show similar qualititative features. Up to 4 eV, structures in both spectra may be attributed to internal electronic transitions of the uranium atom, almost independent of stoichiometry. The broad structure in both spectra up to 8 eV shows a significant shift of the absorption edge from about 5eV for UO_2, to about 4 eV for U_4O_9. This shift can be explained by the reduction of the fcc Brillouin zone due to the 4 times larger lattice constant of U_4O_9. The high energy transition for both UO_2 and U_4O_9 may be described by a mean band gap known as the Penn-gap, and attributed to the valence-to-conduction band excitation. The calculated loss function is compared with the results of the first electron energy loss experiments on UO_2 showing good agreement. Plasma oscillations of valence and uranium 5f-electrons are discussed. Sum rules are applied to calculate the effective dielectric constant and the effective number of electrons involved; this number is found to be well in agreement with a suggested qualitative band scheme, that has been derived by comparing in a critical way existing band calculations for NaCl-type uranium compounds and for CaF_2. By means of the dielectric theory of chemical bonding, the ionicity of UO_2 and U_4O_9 has been determined to be 0.82 and 0.80, respectively, thus confirming, nonwithstanding the typical ionic behaviour of the two solids, the importance of covalent contribution to the bonding.

41843 Electrical resistivity of uranium monophosphides, uranium mononitrides and uranium carbonitrides at low temperatures. Nasu, S.; Kurasawa, T. (Japan Atomic Energy Research Institute, Tokai-mura, Ibaraki-ken, Japan); Matsui, H.; Tamaki, M.; Okuda, M. (Nagoya Univ. (Japan). Faculty of Engineering). pp 515-523 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The temperature dependence of the electrical resistivity has been investigated for sintered UP, monocrystalline UN and plasma-jet fused UC(0.04)N(0.96) and UC(0.09)N(0.91) in the temperature range between 3 and 90°K. A rapid increase in the resistivity of UP (rho(22.43 K) = 4.33xrho(22.14 K)) is observed at the moment jump temperature of 22.40 °K. The resistivity of UP follows a quadratic power dependence below two third of the moment jump temperature. In UN and UC(0.04)N(0.96) a broad maximum followed by a minimum at higher temperatures is observed in the computed temerature derivative curve (drho/dT Vs. T). The resistivity of UN follows a cubic power dependence below the Neel temperature. In UC(0.09)N(0.91) no pronounced change is observed in the drho/dT.

41844 Lattice defects in actinide carbides and their relation to physical properties. de Novion, C.H. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Section d'Etude des Solides Irradies). pp 877-892 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

Stoichiometry defects in actinide carbides are first described and their influence on lattice, electronic and thermodynamic properties are reviewed. Then thermally activated point defects, self-diffusion data and mechanisms, dislocations, plastic deformation, radiation damage, impurities (H,N,O, noble gases) in actinide carbides, mostly UC are dealt with.

41845 Advances in vapour pressure studies over liquid uranium plutonium oxides up to 5000K. Ohse, R.W.; Berrie, P.G. (Commission of the European Communities, Karlsruhe (Germany, F.R.). European Inst. for Transuranium Elements); Brumme, G.D. (Technische Hochschule Darmstadt (Germany, F.R.)). pp 191-201 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

Vapour pressure measurements over liquid (Usub(0.80)Pusub(0.20))Osub(1.95) between 4000 K and 5000 K have been extended below 4000 K. In previous studies a radial displacement of liquid and subsequent crater formation, caused by the recoil force of the vapour jet during laser heating, prevented meaningful measurements below 4000 K. This effect could be eliminated by restricting the liquid layer thickness to the minimum value at the final steady state temperature, by shortening the rise time of the temperature, using a new double intensity laser pulse heating technique with a high initial density, and by focal spot enlargement. The new series of measurements, applying a high-speed multi-wavelength pyrometer, waveform analyzing and data processing system, confirmed the previously presented equation: log p(atm) = 7.966 - 28.137/T. and heat of evaporation ΔHsub(evap) = 128.7 kcal/mol below 4000 K.

41846 Evaporation behaviour of the ternary uranium plutonium carbides. Ohse, R.W.; Capone, F. (Commission of the European Communities, Karlsruhe (Germany, F.R.). European Inst. for Transuranium Elements). pp 245-255 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The evaporation behaviour of uranium plutonium carbides (Usub(0.80)Psub(0.20)Csub(1+-x) was studied by a combined application of mass spectrometry, using the uranium isotope U-233, and the Knudsen effusion target collection technique in the temperature range from 1500°C to the liquids temperature measured at 2458°C and the composition range from C/M = 0.95 to 1.4. High temperature compatibility tests were made with W-cells, carburized Ta and TaC-liners up to 2500°C. The influence of oxygen and nitrogen impurities on vapour pressure, and composition changes in continued evaporation of the the mixed carbides were investigated. The effects of plutonium depletion and segregation were studied.

41847 Electrical conductivity of (U,Pu) Osub(2+-x) in the pure state and with addition of molybdenum. Schmitz, F.; Couty, Y. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France)). pp 165-170 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The influence of the oxygen to metal ratio and of the addition of molydbenum on the electrical conductivity of (UPu)Osub(2+-x) has been measured in the temperature range 350 to 750°C. The results, on molybdenum free oxide, show for increasing O/M ratios, a characteristic decrease of conductivity in the 2-x region, a rapid increase at the stoichiometric composition, followed finally by a progressive increase in the 2+x region. Addition of Mo changes the form of the resistivity curve only for O/M<2.005 : resistivity is then independent of O/M, which means that Mo oxidizes and behaves as a buffer stabilizing the value of O/U+Pu = 2.005 at 800°C. The experimental results together with recently published data on cation diffusion in hypostoichiometric mixed oxide are used to discuss a tentative model for the defect structure of (UPu)Osub(2-x).

41848 Thermodynamic studies at higher temperatures of the phase relationships of substoichiometric plutonium and uranium/plutonium oxides. Soerensen, O.T. (Danish Atomic Energy Commission, Risoe. Research Establishment). pp 123-131 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

Partial molar thermodynamic quantities for oxygen in non-stoichiometric Pu and U/Pu oxides were determined by thermogravimetric measurements in CO/CO_2 mixtures in the temperature range 900-1450°C. A detailed analysis of the thermodynamic data obtained, as well as data previously published for these oxides, shows that the substoichiometric phase range in the phase diagram, previously described as a grossly non-stoichiometric single phase, can be divided into several subregions each with a characteristic type of defect. The pattern of subregions found for the mixed oxides is not the same as that found for PuOsub(2-x) because of the greater stability of the mixed oxides. High temperature X-ray diffractometry measurements which were performed on corresponding U/Ce oxides, also reveal this increased stability of mixed oxide systems.

41849 Electronic structure of uranyl compounds - an XPS study. Veal, B.W.; Lam, D.J.; Hoekstra, H.R.; Carnall, W.T. (Argonne National Lab., Ill. (USA)). pp 383-391 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

X-ray photoemission spectroscopy (XPS) measurements are reported for a series of uranyl compounds in which the primary uranium-oxygen (U-Osub(I)) separation varies substantially. The observation of crystal field splittings of the U 6psub(3/2) core electron energy levels is reported. These splittings are interpreted with the point charge crystal field model when both first and second near uranium neighbors are considered. The systematics of charge migration (observed by monitoring electron core level shifts) associated with bonding in the uranyl series were also investigated. Core level shifts for compounds with different U-Osub(I) separations are large but essentially no relative shifts of uranium and oxygen core levels were observed within the uranyl group. Thus charge appears to flow between the uranyl group (as a unit) and the secondary uranium ligands as U-Osub(I) is varied. U 5f electron participlation in covalent bonding has been studied by systematically measuring XPS line intensities; U 5f electron occupation appears to be minimal.

41850 Bonding and valence in uranium compounds with oxygen: a study by X-ray photoelectron spectroscopy and electron paramagnetic resonance. Verbist, J.J.; Riga, J.; Tenret-Noel, C.; Pireaux, J.J.; d'Ursel, G.; Caudano, R.; Derouane, E.G. (Facultes Universitaires Notre-Dame de la Paix, Namur (Belgium)). pp 409-419 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

Uranium oxides UO_2, U_2O_5, U_3O_8 and UO_3 have been studied by X-ray photoemission (E.S.C.A.) and electron paramagnetic resonance. Binding energy values are reported for the U4f core levels, showing that U_2O_5 is UO_2. UO_3 and U_3O_8 is $UO_2.2UO_3$. Valence band structures are discussed in relation with the formation of $(UO_2)^{2+}$ groups. Results from EPR spectroscopy support the view that no U(V) species are presented in these compounds.

41851 Measurements of the electrical resistance of UO_2-pins at high temperatures. Alexas, A.; Lindner, W. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Lab. fuer Aerosolphysik und Filtertechnik). *J. Nucl. Mater.;* **64**: No. 1, . 220-222(Jan 1977).

In these experiments the total resistance of UO_2-pins of different lengths and densities was measured in an isothermal mode for different electric power levels. The UO_2 samples were subjected to direct electrical heating and brought to the desired rod power without forced cooling. In the steady-state condition both the current and the voltage were recorded from which the total resistance

was deduced. For measurements up to T = 1500 K an hysteresis effect could be determined which disappears again at elevated temperatures. At these higher temperatures no effects due to different grain sizes could be observed. In addition, a new mathematical relationship is proposed for the electrical resistivity of UO_2 and the temperature which describes the experimental results.

41852 Lambda-type heat capacity anomalies in U_3O_8. Inaba, H.; Shimizu, H.; Naito, K. (Nagoya Univ. (Japan). Faculty of Engineering). *J. Nucl. Mater.;* **64**: No. 1, 66-70(Jan 1977).

The heat capacity of U_3O_8 was measured in the temperature range from 310 to 970 K using an adiabatic scanning calorimeter. Three lambda-type heat capacity anomalies were observed at 483, 568 K and 850 K, indicating second order phase transitions. The enthalpy and entropy changes for these anomalies were 135, 148 and 314J mol^{-1}, and 0.28, 0.26 and 0.37 J $mol^{-1} K^{-1}$, respectively. A high temperature X-ray diffraction study has also been undertaken to confirm these phase transitions. The first anomaly at 483 K involves the structural change from orthorhombic to pseudohexagonal (strictly speaking orthorhombic). The origin of the other two phase transitions is not yet clear, but some order-disorder process would be involved in these phase transitions.

41853 Gradients of U, Pu and O at surfaces of (U, Pu)Osub(2+-x). Matzke, H.; Lambert, R.A. (Commission of the European Communities, Karlsruhe (Germany, F.R.). European Inst. for Transuranium Elements). *J. Nucl. Mater.;* **64**: No. 1, . 211-219(Jan 1977).

Due to slow metal atom diffusion, non-congruent evaporation of (U, Pu)Osub(2+-x) may lead to pronounced gradients of U and Pu at the surfaces of preannealed or as-sintered specimens. The Pu content at the surface can easily decrease (for reduced oxides) or increase (for near stoichiometric or oxidized specimens) by a factor of 2. The metal atom gradient thus formed causes an oxygen gradient. Such gradients frequently remain undetected by chemical analysis since normally they only extend to a depth of about 0.1 to 5 μm. Yet, they can drastically affect (and probably have done) quite a variety of physical measurements reported in the literature. The errors involved can easily be larger than an order of magnitude.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 41355, 41487

41854 Lattice defects and irradiation damage in ThO_2, UO_2 and $(U,Pu)O_2$. Matzke, H. (Commission of the European Communities, Karlsruhe (Germany, F.R.). European Inst. for Transuranium Elements). pp 801-831 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

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A critical assessment of the experimental data on lattice defects in the actinide oxides shows that understanding of these defects is still limited. Some of the commonly accepted lieterature data, particularly those on metal self-diffusion are misleading and in part founded on artifacts. Theoretical calculations of defect energies are so far based on ionic models whereas a steadily increasing amount of evidence points towards a pronounced covalent contribution to the bonding in actinide oxides, the concept of isolated point defects is increasingly losing its attraction and is being replaced by micro-domain and cluster models. The virtually complete elimination of point defects by the formation of shear structures must also be considered. Understanding of the majority defects in the oxygen sublattice is shown to be reasonably consistent and satisfactory. In contrast, much of the knowledge on the minority defects in the metal sublattice seems to be incorrect. New diffusion results are reported, and related properties (creep, grain growth, sintering) are discussed as well as plastic properties and irradiation damage effects. Revised defect energies are proposed based on recent new diffusion results and theoretical calculations as well as on a comparison with other substances of the fluorite structure. The relative merits of defect models based on either O/M-ratios or on metal atom valences are discussed. Inconsistencies and gaps in the thermodynamic data are pointed out and a list of urgent questions for future work is assembled.

41855 Recovery processes in quenched and neutron irradiated uranium dioxide. Vollath, D. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung). pp 843-850 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

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Recovery measurements give an insight into the migration processes taking place in the lattice. To understand diffusion processes these data on migration of individual lattice components must be available. Knowledge of such data on recovery processes in the lattice becomes a requirement if very complicated dependencies exist of the diffusion coefficients on the stoichiometry, i.e. the oxygen content of the lattice, such as in the case of the uranium dioxide. This work deals with the migration processes taking place in the lattice of uranium dioxide of nearly stoichiometric composition or slightly hypo- or hyperstoichiometric composition.

41856 Enhancement of U_2C_3 deposition in electron bombarded $UC+UC_2$. Inoue, T.; Matsui, H.; Kirihara, T. (Nagoya Univ. (Japan). Faculty of Engineering). pp 935-941 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

An alloy of $UC+UC_2$ (C/U=1.5) was irradiated with 2 MeV electrons. The resistivity of the alloy increased with increasing electron dose at liquid nitrogen temperature. The increase in resistivity might be due to the formation of nuclei of U_2C_3. The enhancement of U_2C_3 deposition in the post-irradiation annealing of the $UC+UC_2$ was investigated by measurements of electrical resistivity and X-ray diffraction analysis. Comparing the temperature dependence of resistivity for the electron bombarded $UC+UC_2$ with that for the non-irradiated one, the enhanced deposition of sesquicarbide was clearly discerned in the former. Isothermal annealings of the bombarded alloy at 1400°C also revealed a rapid increase in the electrical resistivity due to the enhanced deposition of U_2C_3.

41857 Structural changes in actinide dioxides under self- and reactor irradiation. Kapshukov, I.I.; Sudakov, L.V.; Shimbarev, E.V.; Baranov, A.Yu.; Yakovlev, G.N. (The Scientific Research Institute of Atomic Reactors Named after V.I. Lenin, Dimitrovgrad, USSR). pp 861-869 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The crystal lattice parameter changes were investigated in ^{244}Cm dioxide and in mixed (Am,Cm) dioxide (of solid solution) containing 10% of ^{242}Cm as well as in some PuO_2 specimens with the different isotopic compositions of Pu irradiated in the reactor. These data allow both to expand the range of dose rate during the dioxide self irradiation and to obtain new information on the effects of fission fragment irradiation upon the actinide dioxide structures.

41858 Fission dose dependence of the lattice parameter change in fuel elements. Kirihara, T.; Nakae, N.; Matsui, H.; Tamaki, M. (Nagoya Univ. (Japan). Faculty of Engineering); Nasu, S.; Kikuchi, T. (Japan Atomic Energy Research Institute, Tokai-mura, Tbarakiken, Japan). pp 903-913 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

Three equations which correspond to each stage of a variation of a lattice parameter with fission dose are introduced from kinetic consideration of defects. Emphasis has been mainly placed on the third stage in which a reduction of expanded lattice proceeds to the steady state. Curves calculated by the equations fit well in all stages of the experimental results and others for UC, UN, and UO_2. Experimental results of UC, powder and plate, prepared from the same arc-melted button are presented below 10^{19} fission/cm^3 and the dissimilarities between them are explained by a variation of quantity of sinks.

41859 Alpha radiation damage in the actinide dioxides. Turcotte, R.P. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). pp 851-859 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

Radiation damage in the actinide dioxides is examined with respect to point defect ingrowth and annealing behavior. In α decay, the α particle is shown to contribute 19% of the total damage. Experimental results for α bombardment, α decay, and fission are compared to displacement theory results. A large difference for ingrowth or damage is demonstrated, but isothermal annealing curves are similar for all three damage types.

COMPOSITE MATERIALS

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 41784

41860 (N—76-24364) Advanced composites: mechanical properties and hardware programs for selected resin matrix materials. Wel-

hart, E.K. (McDonnell-Douglas Technical Services Co., Inc., Houston, Tex. (USA)). 31 Mar 1976. Contract NAS9-13970. 38p. (NASA-CR—147705; REPT—1.2-DN-B-0104-1). NTIS $4.00.

This design note presents typical mechanical properties tabulated from industrial and governmental agencies' test programs. All data are correlated to specific products and all of the best known products are presented. The data include six epoxies, eight polyimides and one polyquinoxaline matrix material. Boron and graphite are the fiber reinforcements. Included are forty-two summaries of advanced (resin matrix) composite programs in existence in the United States. It is concluded that the selection of appropriate matrices, the geometric manner in which the fibers are incorporated in the matrix, and the durability of the bond between fiber and matrix establish the end properties of the composite material and the performance of the fabricated structure.

41861 (N—76-27359) **Nonlinear analysis of laminated fibrous composites.** Renieri, G.D.; Herakovich, C.T. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA). Dept. of Engineering Science and Mechanics). Jun 1976. Contract NGR-47-004-090. 193p. (NASA-CR—148317; VPI-E—76-10). NTIS, PC A09/MF A01.

A computerized analysis of the nonlinear behavior of fibrous composite laminates including axial loading, thermal loading, temperature dependent properties, and edge effects is presented. Ramberg—Osgood approximations are used to represent lamina stress—strain behavior, and percent retention curves are employed to model the variation of properties with temperature. Balanced, symmetric laminates comprised of either boron/epoxy, graphite/epoxy, or borsic—aluminum are analyzed using a quasi-three-dimensional finite element analysis. Results are presented for the interlaminar stress distributions in cross-ply, angle-ply, and more complex laminates. Nonlinear stress—strain curves for a variety of composite laminates in tension and compression are obtained and compared to other existing theories and experimental results.

41862 (N—76-30026) **Materials research at Stanford University. Annual report, 1 Jul 1975—30 Jun 1976.** (Stanford Univ., Calif. (USA)). 30 Jun 1976. Contract NSF DMR-72-03022. 411p. (NASA-CR—148579; CMR—76-8). NTIS $11.00.

Subm-Sponsored in Part by NASA.

Information briefly describing the total research activity related to the science of materials is reported. Emphasis is placed on physical and mechanical properties of composite materials, energy transportation, superconductors, microwave electronics, and solid state electrochemistry. (GRA)

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 41784, 41862

OTHER MATERIALS

REFER ALSO TO CITATION(S) 40934

PREPARATION AND MANUFACTURE

REFER ALSO TO CITATION(S) 41168

STRUCTURE AND PHASE STUDIES

41863 (CONF-770116—1) **Theoretical concepts useful in the calculation or storage of phase diagrams of ionic systems.** Saboungi, M.L.; Blander, M. (Argonne National Lab., Ill. (USA)). Jan 1977. Contract W-31-109-ENG-38. 20p. Dep. NTIS, PC A02/MF A01.

From Workshop on application of phase diagrams in metallurgy and ceramics; Gaithersburg, Maryland, United States of America (USA) (10 Jan 1977).

Equations for the a priori calculation or for the storage of phase diagrams and thermodynamic properties of molten ternary ionic systems were derived from the conformal ionic solution theory, which rigorously takes into account the ionic nature of the melts. Thermodynamic functions for ternary ionic systems were derived for cases in which all the cations have the same charge and all the anions have the same charge. Equations for the excess free energy of mixing, ΔG/ sup E/, are obtained for reciprocal systems, e.g., A^+, B^+/X^-, Y^-, defined by the three components AY, BX, and BY, and for additive systems, e.g., A^+, B^+, C^+/X^-. From these equations and classical thermodynamic relations, one can calculate phase diagrams of the two classes of ternary systems a priori from data on the lower order systems. Comparisons of such calculations with experimental data were made for liquidus phase diagrams and miscibility gaps in a number of ternary systems; the agreement was generally very good. An empirical extension of the theory to a broader range of systems, in which a pair of cations or anions have different charges, led to a good representation of the phase diagrams. The success of these calculations indicates their usefulness in evaluating the self-consistency of measurements and in the extrapolation of data into unmeasured regions. The equations should also prove useful for the storage of phase diagrams. The accuracy of such stored information can be improved by treating the coefficients as somewhat adjustable parameters and by adding more terms.

41864 **Electronic structure of mixed uranium-thorium monochalcogenides.** Haessler, M. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France)); de Novion, C.H. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Section d'Etude des Solides Irradies); Damien, D. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Genie Radioactif). pp 649-657 of In Plutonium 1975 and other actinides. Blank, H.; Lindner, R. (eds.). Amsterdam, The Netherlands; North-Holland (1976).

From 5. international conference on plutonium and other actinides; Baden Baden, Germany, F.R. (10 - 13 Sep 1975).

The electrical resistivity and magnetic susceptibility of a dilute solution of uranium in ThS, as well as the magnetic susceptibility of (Usub(x)Thsub(1-x)) Te mixed tellurides have been measured between 4 and 300 K. Dilute (Th,U)S sulphides are satisfactorily described by localized spin fluctuations with a spin fluctuation temperature of approximately 150 K. In contrast, the behaviour of a dilute solution of uranium in the ThTe (of CsCl type structure) is that of a magnetic 5f bound state. Crystal structure and lattice parameters of mixed (Usub(x)Thsub(1-x))Te are determined at room temperature.

PROPERTIES

REFER ALSO TO CITATION(S) 41482

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 41355

CHEMISTRY

ANALYTICAL AND SEPARATIONS CHEMISTRY

ACTIVATION AND NUCLEAR REACTION PROCEDURES

REFER ALSO TO CITATION(S) 41009, 41027

41865 (CEA-CONF—3657) **Application of Bremsstrahlung activation analysis to the determination of carbon and nitrogen in sodium.** Bock, P.; Engelmann, C.; Hatterer, A. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Recherche et Analyse). 1976. 11p. (CONF-760915—10). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Modern trend in activation analysis; Munich, German, Federal Republic of (F.R. Germany) (13 Sep 1976).

Carbon and nitrogen are determined by means of the photonuclear reactions: $^{12}C(\gamma,n)^{11}C$ and $^{14}N(\gamma,n)^{13}N$. A simultaneous chemical separation method for the isolation of carbon-11 and nitrogen-13 is presented. It is based on combustion of the sample, after irradiation and etching, in a mixture of oxidizing acid fused salts (B_2O_3 and Pb_3O_4) containing a dispersing agent (NaCl and KCl) and the respective carriers. Each analysis takes about 40 minutes altogether. Minimum carbon and nitrogen contents of a few $10^{-2}\mu g.g^{-1}$ can be measured. The influence of the main competitive nuclear reactions on neighboring elements, including Na itself is examined and it is shown that the two elements considered can be measured without risk of interference if the irradiation energy is suitably chosen. The analysis of Na from experimental loops and reactor cooling circuits is described by way of example.

41866 **Application of fission track registration technique in the estimation of fissile materials. Analysis of plutonium in solutions of complex matrices.** Chaudhuri, N.K.; Sampathkumar, R.; Iyer, R.H. (Bhabha Atomic Research Centre, Bombay (India). Radiochemistry Div.). *J. Radioanal. Chem.;* **33**: No. 1, 53-65(1976).

4 figs.; 5 refs.; 1 tab.

Analysis of fissile materials in solution by fission track registration technique has been extended to plutonium in solution of its alloys. In these estimations, the results agreed within 1-4% with the average of those obtained by other chemical and instrumental methods like potentiometry, mass-spectrometry and X-ray fluorescence. Some special problems encountered in the analysis of plutonium solutions are noted. Various factors affecting the results have been investigated and the necessary precautions for reducing these errors have been indicated. The advantages of the method over some other conventional methods have also been discussed. It is suggested that a source of about 10 μg of ^{252}Cf corresponding to a neutron flux of about $10^7 n\ cm^{-2}s^{-1}$ is ideal for these experiments.

CHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 41000, 41015, 41017, 41018, 41019, 41020

41867 Naturally occurring nitrosatable amines. II. Secondary amines in tobacco and cigarette smoke condensate. Singer, G.M.; Lijinsky, W. (Oak Ridge National Lab., TN). *J. Agric. Food Chem.;* **24**: No. 3, 553-555(1976).

The previously described method for isolation and identification of naturally occurring secondary amines has been applied to tobacco and cigarette smoke condensate ("tar"). Pyrrolidine and dimethylamine are the predominant amines found in both substances.

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 42093, 42099, 42107, 42108

SPECTRAL PROCEDURES

REFER ALSO TO CITATION(S) 40811, 40826, 40834, 40835, 40836, 40968, 40992, 40993, 40994, 41006, 41007, 41008, 41009, 41012, 41013, 41014, 41016, 41017, 41021, 41022, 41023

41868 (ARH-SA—279) **Laser Raman spectrometric determination of oxy-anions in nuclear waste materials.** Miller, A.G. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Mar 1977. Contract EY-76-C-06-2130. 28p. (CONF-770301—7). Dep. NTIS, PC A03/MF A01.

From 173. national meeting of the American Chemical Society; New Orleans, Louisiana, United States of America (USA) (20 Mar 1977).

Oxy-anions in complex nuclear process-waste materials are being determined by laser Raman spectrometry (LRS). The double internal-standard technique developed by Marston is applied to the simultaneous determination of up to x anions in alkaline solutions. The method of Marston has been extended to solutions prepared from the solids formed in nuclear waste storage tanks. As many as six anions, aluminate, chromate, nitrate, nitrite, phosphate, and sulfate, are simultaneously determined in about one hour. Carbonate may also be determined, but in the presence of the prevalent nitrate, a chemical separation is required. Individual methods have been relegated to a secondary status due to the many advantages of LRS. Advantages such as small sample size, speed of analysis, accuracy, and specificity will be discussed. The typical precision obtained for analyses in high concentration is around five percent relative standard deviation.

41869 Characterization of naphthalenedicarboxylic acids. I. Ultraviolet absorption spectra. Davies, C. pp 14-21 of In Extraction of useful chemical derivatives from coal. New York; MSS Information Corporation (1976).

The ten isomeric naphthalene dicarboxylic acids have been prepared using standard methods, and the ultraviolet absorption spectra of these acids in water have been obtained. The spectra and molar extinction coefficients can serve to characterize these acids, which may be found in the products of the oxidative degradation of coal.

SEPARATION PROCEDURES

REFER ALSO TO CITATION(S) 40993, 41024

41870 (AD-A—026899) **Development of high pressure liquid chromatographic techniques. Final report.** Walters, E.A. (New Mexico Univ., Albuquerque (USA). Eric H. Wang Civil Engineering Research Facility). May 1976. Contract F29601-74-C-0030. 48p. (CERF-EE—3). NTIS $4.00.

This is an interim report on a continuing study of the application of High Pressure Liquid Chromatographic (HPLC) techniques to water pollution problems. Reported herein are developmental data on three new detection systems; an ultrasonic velocity detector, a beta-induced luminescence detector, and a specific solid-state silver-ion detector. Preliminary results of work on separations in natural waters and in sewage effluents using HPLC techniques and an extensive literature survey on HPLC are also included. (GRA)

41871 (AD-A—030683) **Effect of intramolecular hydrogen bonding on partition coefficients. Technical note.** Holmes, H.L.; Lough, C.E. (Defence Research Establishment Suffield, Ralston, Alberta (Canada)). Jul 1976. 24p. (DRES-TN—365). NTIS $3.50.

Hansch favors the use of 1-octanol-water for partitioning organic compounds. The advantage ascribed to this and other alcohol-water systems is that the same equation serves to calculate log P(alc-water) values for compounds with and without intermolecular hydrogen bonding. Hansch and others have attempted, without much success, to develop equations for calculating the effect of intermolecular hydrogen bonding upon partition coefficients determined in hydrocarbon water systems. In this paper, attention is directed towards a similar study of phenols with a functional group at C2 or C4. Using conjugative effects, millimicron units, and steric effects, millimicron units, developed for calculating long-wavelength U.V. absorption maxima of the conjugated heteroenoid compounds, permitted the development of equations relating log P (in the system cyclohexane-water) and log P' (in the system 1-octanol-water) for 2-hydroxy-derivatives to those for the respective isomers with the hydroxyl at C4. Incorporation of pK(A) into equations analogous to those above related log P(para) and log P(para) for the 4-hydroxy derivatives respectively to log PH and log PH for the parent compounds. Addition of the appropriate equations from the above two sets permits the calculation of log P(ortho) values for 2-hydroxy derivatives in the system cyclohexane-water, where intramolecular hydrogen bonding occurs, from log PH values. Methods for calculating log PH and log PH values have already been outlined. (auth)

INORGANIC AND PHYSICAL CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 41164, 41173, 41877

41872 (AD-A—034515) **Determination of absolute photon yields in chemiluminescent reactions. Annual technical report, 3 Dec 1975—2 Dec 1976.** Zare, R.N. (Columbia Univ., New York (USA). Dept. of Chemistry). Dec 1976. Contract N00014-76-C-04666. 38p. NTIS, PC A03/MF A01.

An experimental procedure is presented to measure the absolute photon yield, the percentage probability of emitting a visible photon per reactant molecule consumed, for chemiluminescent reactions under single collision conditions. Using a well-defined metal beam directed into a scattering gas at sub-millitorr pressures, this procedure is applied to the reactions $Sm + N_2O$, $Sm + F_2$, $Ba + N_2O$, and $Ba + NO_2$ to obtain the photon yields in the 350-800 nm range of 0.18%, 5.5%, 1.1% and 0.08% respectively, where the estimated uncertainty is about 50%.

41873 Heats of dilution of some aqueous rare earth electrolyte solutions at 25°C. I. Rare earth perchlorates. Spedding, F.H.; Mohs, M.A.; Derer, J.L.; Habenschuss, A. (Ames Lab., Iowa). *J. Chem. Eng. Data;* **22**: No. 2, 142-153(Apr 1977).

The heats of dilution of aqueous $La(ClO_4)_3$, $Pr(ClO_4)_3$, $Nd(ClO_4)_3$, $Sm(ClO_4)_3$, $Gd(ClO_4)_3$, $Dy(ClO_4)_3$, $Er(ClO_4)_3$, and $Lu(ClO_4)_3$ solutions have been determined from approximately 0.001 m to saturation at 25°C. The integral heats of solution of $La(ClO_4)_3 \cdot 8H_2O$, $Nd(ClO_4)_3 \cdot 8H_2O$, $Gd(ClO_4)_3 \cdot 8H_2O$, and $Er(ClO_4)_3 \cdot 8H_2O$ in water at 25°C have also been measured. The heat of dilution data are represented by empirical polynomial equations, and relative apparent and partial molal heat contents are calculated. The heat content data are correlated with the inner sphere water coordination numbers of the rare earth cations.

41874 Isopiestic determination of the activity coefficients of some aqueous rare earth electrolyte solutions at 25°C. II. The rare earth perchlorates. Rard, J.A.; Weber, H.O.; Spedding, F.H. (Ames Lab., Iowa). *J. Chem. Eng. Data;* **22**: No. 2, 187-201(Apr 1977).

The osmotic coefficients of the aqueous triperchlorates of La, Pr, Nd, Sm, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu have been measured from 0.1 m to saturation at 25°C. These data were fitted to semiempirical least-squares equations, and these equations were used to calculate water activities and mean molal activity coefficients for each electrolyte. The water activities of these solutions are much lower than for the corresponding rare earth chlorides at the same molalities, whereas the activity coefficients of the rare earth perchlorates are much larger. This behavior and changes in these properties across the rare earth series are discussed in terms of differences in interactions between anions, cations, and water, including the effect of the rare earth ionic radius upon cation hydration.

ORGANIC CHEMISTRY

REFER ALSO TO CITATION(S) 40953

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 40800, 40807, 40818, 40819, 40820, 40822, 40826, 40830, 40833, 41065

41875 Oxidative-reductive transformations of the quinoid groups of humic acids. Kulesh, N.I.; Maksimov, O.B. (Pac-Ocean Inst of Bioorg Chem, USSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 1, 1-5(1976).

The quinoid groups of humic acids of the soil, peat, and coals are capable of readily undergoing reversible oxidative-reductive transformations which, together with their capacity for ion exchange, is a fundamental characteristic of this class of natural compounds. A comparative kinetic study of the oxidation of reduced model quinones and humic acids has shown the presence of various types of quinoid groups in the latter. According to their reactivities, the quinoid groups of humic acids can be subdivided into three types, the behavior of which in redox reactions corresponds to ortho- and para-benzoquinones and hydroxyanthraquinones. 11 refs.

41876 Investigation of the kinetics of the oxidation of schungite and of glassy carbon. Elizen, V.M. (Inst of Heteroorg Compd, Acad of Sci of the USSR). *Solid Fuel Chem. (USSR) (Engl. Transl.);* **10**: No. 1, 59-61(1976).

In the reported experiments, the kinetics of the oxidation of samples of schungite and glassy carbon with various temperatures of thermal treatment by a solution of potassium dichromate in phosphoric acid has been studied. A temporal separation of two processes differing in rate was found which correlated with the complex nature of the x-ray diffraction band (002), consisting of the superposition of two and three bands, and also with two exothermic maxima on the DTA curves on the oxidation of the samples with atmospheric oxygen. An explanation of the effects observed is given from the point of view of features of the chemical structure of the carbonaceous matter of schungite and of glassy carbon. A similarity of the schungite and glassy carbon in reactivity to oxidation has been shown which is due to a similarity of the chemical structures of their carbonaceous matters. 8 refs.

ELECTROCHEMISTRY

REFER ALSO TO CITATION(S) 41862, 41874

41877 Review of osmotic coefficients of aqueous $CaCl_2$ at 25°C. Rard, J.A.; Habenschuss, A.; Spedding, F.H. (Ames Lab., Iowa). *J. Chem. Eng. Data;* **22**: No. 2, 180-186(Apr 1977).

New data have become available since Robinson and Stokes' review of the use of $CaCl_2$ solutions as isopiestic standards. Electrolyte activity coefficient and water activity determinations for aqueous $CaCl_2$ solutions from vapor pressure, isopiestic, freezing point depression, emf, and diffusion coefficient measurements are reviewed here. These activities have been updated to presently accepted values of the physical constants, and vapor pressure measurements have been corrected for the nonideal behavior of the solvent vapor. A semiempirical equation is given which represents the osmotic coefficients of aqueous $CaCl_2$ solutions at 25°C from 0 to 9 m, to within the experimental uncertainty of the data. This equation is recommended for all isopiestic measurements using a $CaCl_2$ standard at 25°C.

RADIATION CHEMISTRY

REFER ALSO TO CITATION(S) 41039

41878 (AD-A—026822) **Viscosity effects in the radiation-induced grafting of vinyl monomers on polyvinylchloride films. Technical report.** Wilson, J.E. (Bishop Coll., Dallas, Tex. (USA)). Jan 1976. Contract N00014-72-C-0052. 32p. NTIS, PC A03/MF A01.

Radiation-induced grafting rates of styrene on polyvinylchloride (PVC) film were measured in a series of runs at various styrene concentrations, while holding constant the Hildebrand solubility parameter of the grafting solution, and therefore theoretically also holding internal film viscosity constant. The results show rate apparently proportional to the first power of styrene concentration. The rate data are compared and contrasted with those obtained in earlier grafting studies by Takamatsu on styrene/PVC. The rate of acrylonitrile grafting on PVC film was also measured, and overall grafting rates for styrene/PVC and acrylonitrile/PVC are compared on the basis of the calculated values of rates of initiation, rates of propagation, internal monomer concentrations, and rates of termination. Internal film viscosities for several monomer/polymer systems were estimated using an equation derived by Smoluchowski, and the relation between internal film viscosity and the rate of termination by macroradical interaction is discussed. (GRA)

PROPERTIES OF RADIOACTIVE MATERIALS

REFER ALSO TO CITATION(S) 41088, 42125

COMBUSTION CHEMISTRY

REFER ALSO TO CITATION(S) 41176, 41963

ENGINEERING

GENERAL ENGINEERING

REFER ALSO TO CITATION(S) 40947

41879 (SAND—76-8262) **Equations of motion for a mass particle elastically mounted on a disk subjected to transverse and rotational accelerations.** Benedetti, G.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). Mar 1977. Contract EY-76-C-04-0789. 26p. Dep. NTIS, PC A03/MF A01.

Equations of motion for a mass particle elastically mounted on a disk which is subjected to transverse and rotational accelerations are derived. The idealized problem considered herein is an approximation to a more complicated problem concerned with the lateral response of a cantilever beam due to the balloting accelerations of a projectile as it accelerates down a rifled gun tube. Some numerical results are presented which illustrate the dynamic behavior of the mass particle when balloting accelerations are present.

FACILITIES AND EQUIPMENT

41880 (SAND—77-8006) **Measurement of residual stresses by the hole-drilling method.** Delameter, W.R.; Mamaros, T.C. (Sandia Labs., Albuquerque, N.Mex. (USA)). Apr 1977. Contract EY-76-C-04-0789. 27p. Dep. NTIS, PC A03/MF A01.

The hole-drilling technique for measuring residual stresses is described. Recommendations for the gathering and reduction of data include some improvements in procedures in order to correct for variations in hole diameter and differences in the elastic constants of the material being tested compared to the established calibration constants relating measured strains to residual stresses. An analytical discussion concerning the two-dimensional elastic solution to the problem of a hole disturbing a uniform state of stress is used to help explain the theory upon which the hole-drilling technique is based, and a similar analysis is used to evaluate the magnitude of error introduced by local plasticity around the hole.

41881 (UCRL—52223) **Numerical simulation of tornado-borne missile impact.** Tu, D.K.; Murray, R.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Feb 1977. Contract W-7405-ENG-48. 44p. Dep. NTIS, PC A03/MF A01.

The feasibility of using a finite element procedure to examine the impact phenomenon of a tornado-borne missile impinging on a reinforced concrete barrier was assessed. The major emphasis of this study was to simulate the impact of a nondeformable missile. Several series of simulations were run, using an 8-in.-dia steel slug as the impacting missile. The numerical results were then compared with experimental field tests and empirical formulas. The work is in support of tornado design practices for fuel reprocessing and fuel fabrication plants.

41882 Bearing application of quick running rotors, particularly of waste gas superchargers. Reisacher, J. German(FRG) Patent 2,403,768/A/. 7 Aug 1975. 9p. (In German).

1 fig.

A bearing application for fast running rotors is described. The object of the invention is to improve the bearing application, to reduce the constructional parameters and fabrication weights of the charger, as well as to simplify and lower the costs of the production. The improvement especially deals with the reduction of the power lost in the bearing and the increase of the stability of the bearing.

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

REFER ALSO TO CITATION(S) 41784, 42296, 42297, 42320

41883 (N—76-27444) **Dewar technology study. Final report.** Davis, W. (Ball Bros. Research Corp., Boulder, Colo. (USA). Aerospace Div.). Oct 1975. Contract NAS8-29848. 122p. (NASA-CR—149921;F—75-20). NTIS $5.50.

The development of a Dewar system for handling liquid helium under weightless conditions is described. Porous plug designs for the prevention of superfluid creep out of the dewar through the vent line were evaluated. For the purpose of designing a neck to provide a transition from the cold cavity to the outside, the loads carried by the neck and equipment supports were studied. Temperature, pressure, and mass flow instrumentation for monitoring Dewar performance were also evaluated. In addition, multilayer blankets consisting of aluminized Mylar separated by Dacron net sheets were designed to insulate the pressure vessel. The dewar system is suggested for use with the star tracking telescope aboard the relativity satellite.

41884 (N—76-30534) **Superconducting lenses for high-voltage microscopy. Final report.** Dietrich, I.; Fox, F.; Knapek, E.; Lefranc, G.; Nachtrieb, K. (Siemens A.G., Muenchen (Germany, F.R.)). Dec 1975. 90p. (BMFT-FB-T—75-44). NTIS $5.00.

A superconducting shielding lens was designed and its applicability as an objective lens in electron microscopy, in particular at high beam voltages, was tested. The following requirements had to be fulfilled: construction of a testing microscope for beam voltages in the 400 kV range, preparation of superconducting material with high shielding capability, orientation investigations outside of the electron microscope to determine image aberrations, and design of specific cryotechnic devices. The resolution test was carried out in a cryogenic lens system consisting of the shielding lens as an objective lens, the iron circuit intermediate lens with a superconducting coil, and superconducting correcting devices. A lattice resolution of 0.34 nm and a point resolution below 0.5 nm at a beam voltage of 350 kV could be proved. A second system, subsequently constructed and containing four superconducting lenses, was provided with a side entry stage.

41885 (PB—261709) **Characterization of a superconducting coil composite and its components. Interim report.** Clark, A.F.; Weston, W.F.; Arp, V.D.; Hust, J.G.; Trapani, R.J. (National Bureau of Standards, Boulder, Colo. (USA)). Jul 1976. 144p. (NBSIR—76-837). NTIS, PC A07/MF A01.

The physical properties of a superconducting coil composite and its components were studied in order to accurately predict the coil behavior under a variety of operating conditions. This second interim report includes data on the Young's moduli, the Poisson's ratios, the shear moduli, and the thermal conductivity of the coil composite as well as the compressive modulus of the fiberglass cloth and the thermal expansion of the Cu/Nb-Ti superconducting wire. In addition, the development of an acoustic technique for the determination of the elastic moduli of the coil composite and the stress analysis of transversely isotropic magnet coils are reported.

PROTECTIVE STRUCTURES AND EQUIPMENT

41886 (K/TL—639) **Scanning electron microscope examination of samples from Herty Foundation in development of fluoride-resistant HEPA filter media.** Petit, G.S.; Weber, C.W. (Oak Ridge Gaseous Diffusion Plant, Tenn. (USA)). 1 Feb 1977. Contract W-7405-ENG-26. 12p. Dep. NTIS, PC A02/MF A01.

According to a limited number of SEM photomicrographs, the tensile strength increase of the filter mats and paper formulated with asbestos and L-134 fibers is caused by gradual attack on the fibers by the corrosive environment (moist air-HF-F_2) and buildup of fluoride salts on the fiber surfaces. These deposits cause cross-linkage or interfiber growth, which accounts for the increase in tensile strength. Longer exposures show evidence of the fibers becoming brittle. The brittle fibers would shear more easily and reduce the tensile strength.

41887 (K/TL—644) **Accelerated test for filter media exposure to fluoride environment.** Petit, G.S.; Wiggins, F.N.; Weber, C.W. (Oak Ridge Gaseous Diffusion Plant, Tenn. (USA)). 1 Feb 1977. Contract W-7405-ENG-26. 14p. Dep. NTIS, PC A05/MF A01.

A simple dip test was devised using 1 wt % HF solution to establish an accelerated test which gives similar information on increase and decrease in tensile strength to that displayed in the exposures in the dynamic test system. Herty Sample Nos. 53, 54, and 56 contained only asbestos and L-134 fibers; their unexposed tensile strength ranged from 60 to 70 g. Herty Sample No. 58 contained asbestos and Johns-Manville L-134 fibers plus 3m's Kel-F binder, and DuPont's fluorinated water-repellant Zepel. This sample had a tensile strength of about 700 g. The tenfold increase in tensile strength due to the additives in Sample No. 58 disguised the tensile strength change by the fibers during both types of test, since most of the strength is due to the additives. (LK)

HANDLING EQUIPMENT AND PROCEDURES

41888 (RFP—2639) **Tank study committee report.** (Atomics International Div., Golden, Colo. (USA). Rocky Flats Plant). 25 Feb 1977. Contract EY-76-C-04-3533. 22p. Dep. NTIS, PC A02/MF A01.

Six major problem areas have surfaced in the past twenty-five years concerning the use of plutonium tankage. The most significant of these involves the use of borosilicate glass as a neutron absorber. Approximately thirty recommendations and criteria resulted from a study of these problem areas. Not all of the criteria and recommendations are unanimously supported by all members of the committee. The committee agrees that problem areas that can be handled on a short-term basis are being pursued expeditiously. Most of the criteria presented will apply to new tankage to be installed. The committee also noted fourteen accomplishments in the last 1½ years directed to the application of the criteria.

SHIPPING CONTAINERS

REFER ALSO TO CITATION(S) 41106, 41107, 41108

41889 (IAEA-CN—36/155) **Research and development of spent fuel shipping casks and the criteria for seagoing vessel carrying casks.** Aoki, S.; Ando, Y. (International Atomic Energy Agency, Vienna (Austria)). 1977. 8p. (CONF-770505—126). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

3.3.-.T.1./01.

Considering that the transportation of spent fuel will increase rapidly and extensively in the near future, Japanese Atomic Energy Committee enacted "Technical Standard for Transportation of Radioactive Materials" based on "IAEA Regulation for the Safe Transport of Radioactive Materials 1973 Revised Edition". Coping with the recommendation of AEC, Atomic Energy Bureau in Science and Technology Agency and other authorities concerned started to review the former ordinances for transportation of radioactive materials and to consolidate a unified system of relevant laws and standards. On the other hand, Atomic Energy Bureau has invested in research and development since ten years ago in order to obtain the data for design and licensing work of spent fuel shipping casks. In those studies some different scale models of a prototype of 80 tons in weight have been used to make clear the scale effect at the drop, pucture and fire tests, which are one of the features of Japanese research and development. And also the immersion test in high pressure water up to about 500 bars is now carried out to investigate the integrity of cask body and sealing structure to prevent leakage of radioactive contents to the ambient when the cask falls into deep sea. In Japan, depending on the site conditions of nuclear plants, almost all transportations of unirradiated and spent fuels are done on the sea. Therefore, in order to secure the safety of transportation, the design criteria of the seagoing vessels for exclusive transportation of spent fuel shipping casks, namely full load shipping, has been enacted, which aims to make minimum the probability of sinking at collison, stranding and other unforeseen accidents at sea and also to restrain radiation exposure of the crew as low as possible.

MINING AND DRILLING EQUIPMENT AND FACILITIES

41890 **Offshore platform.** Schenck, W. (to Holzmann (Philipp) A.G.). German(FRG) Patent 2,457,536/A/. 10 Jun 1976. 21p. (In German).

11 figs.

An offshore platform for deep water for firm standing support on the sea bed is described. The platform consists of a base with one or several legs jutting out of it. Furthermore, means of storage of transported raw materials and of materials necessary for use are provided. Above the water level, there is a working platform fixed to the legs. The platform is prefabricated ashore and is moved to its site of application in a single working process.

LASERS

REFER ALSO TO CITATION(S) 42195

41891 (AD-A—026576) **Variable-aperture calorimeter for an unstable resonator. Interim report.** Chodzko, R.A.; Mason, S.B.; Giedt, R.R.; Durran, D.A. (Aerospace Corp., El Segundo, Calif. (USA). Aerophysics Lab.). 1 Jun 1976. Contract F04701-75-C-0076. 23p. NTIS $3.50.

A new technique for measuring the output power from a cw edge-coupled unstable resonator has been developed and applied to a cw DF laser. An internal-cavity calorimeter was used that permits measurement of output power with a variable rectangular-mode geometry while containing the radiation inside the resonator. The variable aperture calorimeter-absorbing scraper (VACAS) device consists of an absorbing copper plate calorimeter assembly, which replaces the 45-deg output coupling mirror of a conventional edge-coupled unstable cavity.

41892 (AD-A—028234) **Design of a high-pressure multi-kilowatt CO_2 laser.** Whitcher, R.E.; McLeary, R. (Materials Research Labs., Maribyrnong (Australia)). Jan 1976. 19p. (MRL—646). NTIS $3.50.

The design of a multi-kilowatt electric-discharge CO_2 laser is described. The laser, which utilizes plasma injection, operates at the relatively high pressure of 30 kPa (0.3 atm). and delivers a continuous output power of 7.5 kW at an efficiency of 10%.

41893 (AD-A—028402) **Chemical laser window measurements. Final report 7 May 1975—6 May 1976.** Harrington, J.A. (Alabama Univ., Huntsville (USA). Div. of Graduate Programs and Research). Jun 1976. Contract DAAH01-75-C-0881. 42p. (UAH-RR—185). NTIS $4.00.

Optical evaluation including absorption coefficient frequency dependence, surface quality, and absorption coefficient determination at the DF laser frequency has been performed for commerically prepared disk shaped samples of potential DF laser window materials. In addition, some of the samples have been exposed to beam intensities of 1600 w/sq. cm. During these exposure tests, a lateral shearing interferometer was used to observe distortion of the surface. The results of the above measurements are presented. Values obtained for the absorption coefficient frequency dependence and the absorption coefficient at 3.8 micrometers are compared to the best values previously obtained in the UAH laboratory for like materials.

41894 (AD-A—029916) **Evaluation of Nd:YVO_4 and Ho:Er:Tm:YVO_4 as pulse pumped q-switched lasers. Final report, 1 Jan 1974—1 Apr 1975.** Bass, M.; DeShazer, L.G.; Yaney, P.P. (University of Southern California, Los Angeles (USA). Center for Laser Studies). Jan 1976. Contract DAAB07-74-C-0104. 117p. NTIS $5.50.

See also AD-A000911.

This program was designed to develop and exploit rare-earth doped yttrium orthovanadate (YVO_4) as a high efficiency laser material. The effort included crystal growth, spectroscopy and laser performance testing. Though emphasis was placed on the spectroscopic and laser properties of Nd(3+) ions, the spectroscopy of Ho(3+) ions with Er(3+) and Tm(3+) co-dopants was also studied.

41895 (AD-A—034326) **Design and development of soft x-ray laser. Semi-annual technical report, Mar—Dec 1976.** Friedman, H.W. (Avco-Everett Research Lab., Everett, Mass. (USA)). Dec 1976. Contract N00173-76-C-0214. 58p. NTIS, PC A04/MF A01.

Progress in the theoretical and experimental effort of the soft x-ray laser work is outlined. The lithium vapor model has been refined to include the effects of autoionization and the stimulated Raman gain of the laser system has been correctly calculated. A single order pulse from the mode locked train of CO_2 pulses has been isolated and is ready to be injected into the 'Big Bang' laser for amplification. The experimental chamber, a vacuum system and focusing optics is complete and the grazing incidence spectrometer is assembled. A dye laser system tuned to 9584 A has been built and tested.

41896 (AD-A—034583) **Optics research, 1976:1. Semiannual technical summary report, 1 Jan—30 Jun 1976.** Rediker, R.H. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 30 Jun 1976. Contract F19628-76-C-0002. 23p. NTIS, PC A02/MF A01.

The following topics are discussed: laser technology and propagation--laser effects (effect of pulse shape and pulse length on enhanced thermal coupling to metals, long-pulse HF laser breakdown experiment); stable CO_2 laser development and evaluation (calibration of $^{14}C^{16}O_2$ laser lines); and pollution studies.

41897 (AD-A—034674) **Analytic modeling of electrically excited D_2/HCl and HCl laser experiments. Final report, 1 Aug 1974—31 May 1976.** Taylor, R.; Caledonia, G.; Lewis, P.; Wu, P.; Teare, J.D. (Physical Sciences, Inc., Wakefield, Mass. (USA)). Jul 1976. Contract N00014-75-C-0035. 146p. (PSI-TR—58). NTIS, PC A07/MF A01.

An analytic capability has been developed to model two types of laser experiments: (1) a D_2/HCl EDL and (2) an e-beam sustainer discharge HCl laser. For the former device, a discharge in D_2/inert gas mixtures provides excitation of the vibrational mode of D_2. This gas is then a supersonically expanded and HCl injected. The gases mix and flow into a cavity where vibrational energy transfer pumps the HCl. Complete modeling of this sequence of steps has been achieved. The relevant electron impact rate constants for D_2 (and H_2) as well as the vibrational energy transfer rate constants for the D_2/HCl molecular system were selected from available data and theory. Comparison of the results of this model with data from the NRL EDL experiment were in qualitative agreement. A conceptual design of a next generation experiment was performed and indicates the requirement for an e-beam sustainer discharge operating at about one atmosphere plenum pressure. A D_2/HCl EDL is predicted to be feasible. In the second experiment, HCl/inert gas mixtures are directly excited by a pulsed, high current e-beam sustainer discharge. The discharge conditions were modeled by developing a set of electron impact cross sections for HCl. The results of model calculations indicate that for the conditions of the NRL experiment, sufficient atoms may be generated in the discharge to prevent attainment of high gain. Definitive modeling of the atom generation is not possible at present.

41898 (AD-A—034680) **Cylindrical polishing technology development program. Final report, 3 Jun 1974—31 Jul 1975.** Milam, T.B. (Pratt and Whitney Aircraft, West Palm Beach, Fla. (USA). Florida Research and Development Center). 31 Jul 1975. Contract N00014-74-C-0338. 27p. (PWA-FR—7108). NTIS, PC A03/MF A01.

Cylindrical optical figures are needed for high energy laser (HEL) mirrors constructed of molybdenum material. The subject program determined the state-of-the-art for polishing molybdenum to cylindrical optical figures and advanced the technology within funding limits. Cylindrical optical figures of lambda/2 (lambda approx 0.5 micrometer) quality were determined to be state-of-the-art at PWA-FRDC during the early stages of the program, but this quality was subsequently improved to lambda/4. It proved to be impractical, if not impossible, to establish quantitative effects of the process variables, or to relate the process to spherical polishing technology. Of the several inspection techniques investigated, the glass test plate/monochromatic light interferometer and the noncontact slit interferometer appeared to be the best available techniques to ensure figure quality specifications are met.

41899 (AD-A—034900) **Effects of oxygen contamination on gas dynamic laser performance.** Watterson, J.B. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio (USA). School of Engineering). Dec 1976. 117p. (GEP/PH—76D-12). NTIS, PC A06/MF A01.

The effects of oxygen in the fuel of a shock-tube driven gas dynamic laser was observed with a four-inch shock tube. Five test gases comprised of ten percent CO_2, three percent H_2O, and varying amounts of N_2 and O_2 were studied. Nominal stagnation conditions were 2000°K and 500 psia. The small-signal gain coefficient was measured on three different rotational transitions for each test gas, permitting a J-line scan to be performed. The gas temperature, vibrational temperature of the upper laser level, and energy available for lasing were calculated using the J-line scan method. It was found that the small-signal gain coefficient, the vibrational temperature of the upper laser level, and the energy available for lasing all decreased linearly as the oxygen concentration in the gas dynamic laser fuel increased. Specifically, an increase in the oxygen content of 1% resulted in a decrease of the gain coefficient by roughly 1.5%. Such a decrease is in agreement with previous work.

41900 (COO—2790-2) **Excitation efficiency and energy storage capabilities of high pressure rare gas—metal vapor mixtures. Final report.** Crane, J.K.; Verdeyen, J.T.; Cherrington, B.E. (Illinois Univ., Urbana (USA)). 1976. Contract EY-76-S-02-2790. 19p. Dep. NTIS, PC A02/MF A01.

Gain has been observed on the 5461A (7^3S_1—6^3P_2) and 3650A (6^3D_3—6^3P_2) transitions in atomic Hg. The media consists of 50 to 150 torr and He and 20 to 50 torr of Hg excited by a 1 μs, pulsed, 0.5 to 4 a/cm² discharge. Gain as high as 10% has been measured with an OSRAM spectral lamp. Gain appears in the afterglow from 2 to 10 μsec after the termination of the discharge pulse. The upper state appears to be pumped by recombination, during which time the lower state is being depopulated by collisions with electrons or Helium atoms.

41901 (COO—4055-1) **Scalable nanosecond CO_2 laser technology. Progress report for period November 7, 1976—January 7, 1977.** (Avco-Everett Research Lab., Everett, Mass. (USA)). Feb 1977. Contract EY-76-C-02-4055. 51p. Dep. NTIS, PC A04/MF A01.

This second bi-monthly progress report on the Scalable Nanosecond CO_2 Laser Technology Program covers work performed from November 8, 1976 to January 7, 1977. Under Task I - Saturable Absorber Studies, small signal absorption measurements over the 9 and 10 μ bands were carried out on various molecules to determine their potential as gain isolators. Saturation and relaxation experiments are being set-up to further evaluate some of these absorber media. Continued modeling and theoretical analyses of saturable absorber media under Task II - Theoretical Studies are providing the necessary inputs in the selection of various molecules. Under Task III - Flowing Saturable Absorber Device, the flow-field structure of gain and absorber regions was studied. A species concentration probe is being built to determine the amount of contamination of the gain medium by saturable absorber medium due to mass diffusion in the mixing layer. The nanosecond CO_2 oscillator is being readied under Task IV - Nanosecond CO_2 Oscillator to conduct saturation experiments of candidate saturable absorber media under both single and multi-line conditions.

41902 (LA-UR—75-2260) **Array laser: a technique for the generation of ultra-high laser intensities.** Carmen, R.L. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-ENG-36. 5p. (CONF-760611—9). Dep. NTIS, PC A02/MF A01.

From International conference on quantum electronics and exhibition; Amsterdam, Netherlands (14 Jun 1976).

The physics of a new concept in large laser-system design are described, which should allow the attainment of focal intensities approaching 10^{21} W/cm². The concept involves the use of many small, coherent beams in a particular orientation which removes alignment difficulties.

41903 (N—76-24562) **Combustion driven cw high power lasers.** Ruppik, H. (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Lampoldshausen (Germany, F.R.). Inst. fuer Chemische Raketenantriebe). 6 Mar 1975. 17p. (DLR-IB—456-75/6). NTIS $3.50.

A survey is presented of cw power lasers using exothermal chemical reactions to produce coherent radiation. Two classes of

combustion lasers, gasdynamic lasers and chemical mixing lasers are differentiated. Examples are given of lasers that work on these principles.

41904 (N—76-27538) **1.06 micrometer wideband laser modulator: fabrication and life testing. Final report, 25 Jul 1974—25 Jul 1975.** Teague, J.R. (McDonnell Douglas Astronautics Co., St. Louis, Mo. (USA). Dept. of Advanced Space Avionics). Sep 1975. Contract NAS5-20605. 172p. (NASA-CR—144783). NTIS $6.75.

The design, fabrication, testing and delivery of an optical modulator which will operate with a mode-locked Nd:YAG laser at 1.06 micrometers were performed. The system transfers data at a nominal rate of 400 Mbps. This wideband laser modulator can transmit either Pulse Gated Binary Modulation (PGBM) or Pulse Polarization Binary Modulation (PPBM) formats. The laser beam enters the modulator and passes through both crystals; approximately 1% of the transmitted beam is split from the main beam and analyzed for the AEC signal; the remaining part of the beam exits the modulator. The delivered modulator when initially aligned and integrated with laser and electronics performed very well. The optical transmission was 69.5%. The static extinction ratio was 69:1. A 1000 hour life test was conducted with the delivered modulator. A 63 bit pseudorandom code signal was used as a driver input. At the conclusion of the life test the modulator optical transmission was 71.5% and the static extinction ratio 65:1. (Author) (GRA)

41905 (PB—253669) **Excitation and relaxation studies of molecular lasers. Annual report, 15 Feb 1975—14 Feb 1976.** DeTemple, T.A. (Illinois Univ., Urbana (USA). Electro-Physics Lab.). Apr 1976. 75p. (UILU-ENG—76-2545). NTIS $4.50.

The development of a hybrid output mirror for optically pumped far infrared lasers is outlined. Use of this mirror permitted a detailed theoretical model for the laser to be developed which exhibited good agreement with experiments. The development of a metal vapor injection furnace has resulted in flow rates of 1 mMole/sec with subsequent run times of 45 minutes. This furnace is being investigated as a metal atom source for metal oxidation chemical lasers and for chemically formed electrically-excited lasers.

41906 (PB—254066) **Application of infrared frequency synthesis techniques with metal-insulator-metal diodes to the spin flip Raman laser.** Wells, J.S.; Streit, G.E.; Petersen, F.R. (National Bureau of Standards, Boulder, Colo. (USA). Time and Frequency Div.). Apr 1976. 17p. (NBS-TN—680). NTIS $3.50.

Infrared frequency synthesis techniques with a metal-insulator-metal (MIM) diode have been extended to include the measurement of the frequency of a spin flip Raman laser (SFRL). As a result of this extension, spectroscopy in the 5.3 micrometer region can be put on a frequency rather than a wavelength metrology basis. Additional observations with the diode are in qualitative agreement with recent work relating to non-linear tuning over axial SFRL modes.

41907 (SAND—76-9314) **Laser velocimetry measurements in the cavity of HF chemical laser (cavity injector type CL-II).** Hackett, C.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Feb 1977. Contract EY-76-C-04-0789. 194p. Dep. NTIS, PC A09/MF A01.

Efforts to develop a non-invasive optical technique that permits measurement of gas/particle velocity distributions within the actual lasing zone of an operational continuous wave combustion driven HF chemical laser device are summarized. The results were obtained for the cavity injector type CL-II. Data were obtained from at least five cavity injector elements for a streamwise range from 3 to 16 intranozzle separation distances, using a scanning Fourier Transform laser velocimeter system to measure the velocity of TiO_2 particles formed by a chemical condensation technique inside the mixing layers between the cavity injector elements. The statistical features of the data ensembles have been analyzed by a computer to obtain both velocity probability distributions and the first four statistical moments of the particle velocity distribution at various locations within the intranozzle mixing layers. Comparative studies using cone pitot-static and two component hot-wire anemometry measurements in analog non-reacting flows have been included for reference. The results indicate that chemical laser cavity flows can be probed using a scanning Fourier Transformed laser velocimeter system and a Lagrangian chemical seeding technique. The spatial resolution is not small enough to study the fine-scale structure of the gas-mixing regions. The measured bimodal particle velocity probability distributions are ambiguous, either because the gas dynamics of the flow itself is unsteady, or the gas-particle kinematics exhibit features that indicate unmixed conditions in the intranozzle shear flow.

41908 (UCRL—13713) **Rare gas monohalide discharge studies. Final report.** (Mathematical Sciences Northwest, Inc., Bellevue, Wash. (USA)). Dec 1976. Contract W-7405-ENG-48;SUB-PO-2810103. 32p. (MSNW—76-1053-1). Dep. NTIS, PC A02/MF A01.

Results of the first phase of an experimental investigation of the minimum e-beam current density requirements for repetitively pulsed XeF lasers with 10 to 100-mJ pulse energy are presented. Measurements were made in the self-sustained and e-beam preionized mode of operation. The e-beam preionized experimental results were similar to those obtained with uv preionization at other laboratories, indicating that ionization phenomena (rather than photodissociation) are dominant in both experiments. Multi-pulse e-beam experiments in a single gas fill resulted in rapid gas degradation, possibly due to electron bombardment of insulated surfaces with subsequent evolution of gaseous impurities.

41909 **Third conference on the laser.** Goldman, L. (ed.). Contract EX-76-C-23-3162. New York; New York Academy of Sciences (1976). 486p. (CONF-750460—).

From 3. conference on the laser; New York, New York, USA (22 Apr 1975).

Separate abstracts were prepared for seven of the included papers. (MOW)

41910 **X ray laser research: guidelines and progress at the Naval Research Laboratory.** Elton, R.C.; Dixon, R.H. (Naval Research Lab., Washington, DC). *Ann. N.Y. Acad. Sci.;* **267**: 3-15(30 Jan 1976).

From 3. conference on the laser; New York, New York, USA (22 Apr 1975).

See CONF-750460—.

Among the proposals for attaining net positive gain in the soft x-ray region, there are five basic processes (photoionization, electron collisional excitation, charge transfer, dielectronic capture, and recombination) for which sufficiently simple formulations exist to attempt a wavelength projection of the necessary pumping conditions. Two particular approaches are described as examples, with emphasis on current results in both numerical modeling and experiments. (MHR)

41911 **New developments in lasers at wavelengths of 3000 A and below.** Ormonde, S. (Quantum Systems, Inc., Albuquerque, NM). *Ann. N.Y. Acad. Sci.;* **267**: 16-29(30 Jan 1976).

From 3. conference on the laser; New York, New York, USA (22 Apr 1975).

See CONF-750460—.

Current work in this wavelength region centers around applications of nonlinear techniques and a variety of high power excitation methods, either direct or by molecular transfer. Examples of some more recently reported operating lasers are summarized. Several currently discussed schemes are indicated. Attention is focused on temporary compound states with lifetimes in the range 10^{-13} to 10^{-16} seconds formed in a collision between two atomic particles. (MHR)

41912 **Resonantly enhanced, nonlinear generation of tunable, coherent, vacuum ultraviolet (vuv) light in atomic vapors.** Sorokin, P.P.; Wynne, J.J.; Armstrong, J.A.; Hodgson, R.T. (IBM Research Center, Yorktown Heights, NY). *Ann. N.Y. Acad. Sci.;* **267**: 30-50(30 Jan 1976).

From 3. conference on the laser; New York, New York, USA (22 Apr 1975).

See CONF-750460—.

The following subjects are discussed: resonantly enhanced multiphoton ionization in Sr, third harmonic generation in Sn vapor, generation of tunable VUV by sum mixing in Sr vapor, resonance enhancement of sum mixing due to autoionizing levels, theory of resonance enhancement of sum mixing due to autoionizing levels, and VUV generation in other systems.

41913 **Nonlinear laser spectroscopy.** Bloembergen, N. (Harvard Univ., Cambridge, MA). *Ann. N.Y. Acad. Sci.;* **267**: 51-60(30 Jan 1976).

From 3. conference on the laser; New York, New York, USA (22 Apr 1975).

See CONF-750460—.

The following subjects are discussed: two-photon Doppler-free spectroscopy and three or four wave parametric light mixing. (MHR)

41914 **Effect of the addition of SF_6 to a N_2 electrical discharge laser.** Judd, O. (Los Alamos Scientific Lab., NM). *IEEE J. Quant. Electron.;* 78-80(Feb 1976).

The electron distribution function was calculated for simulated conditions of SF_6-N_2 gas mixtures under conditions typical of a N_2 electrical discharge laser. The results indicate that the electron distribution function, transport quantities, and electronic excitation rates change only a few percent in the presence of SF_6, provided E/N is unchanged. The enhancement in laser output with the addition of SF_6 is attributed to an increased operating value of E/N in the electrical discharge.

41915 **Superradiative rare gas halide lasers excited by electric discharge.** Ishchenko, V.N.; Lisitsyn, V.N.; Razhev, A.M. (AN SSSR, Novosibirsk. Inst. Fiziki Poluprovodnikov). *Appl. Phys.;* **12**: No. 1, 55-58(Jan 1977).

3 figs.; 15 refs.

High-power stimulated radiation was obtained in three fluorides of rare gases by exciting a high pressure mixture of He + R + SF_6 (R is argon, krypton, xenon) by a pulse electric discharge (mixture pressure ranged from 1 to 10 atm). The ArF laser superradiance spectrum of about 15 A total width with the center at lambda = 1,932 A is given. The ArF laser power was P approximately 10^4 W. The KrF laser generated 2 ns pulses of about 2.5 MW power at lambda = 2,486 A with a linewidth Δ lambda approximately 10 A. This laser efficiency in relation to the stored energy of an accumulator is about 0.2%. In the XeF laser P = 200 to 300 kW, tau = 3 to 3.5 ns, lambda = 3,511, 3,531 A. High density of superradiance power is observed. The prospects of increase of mean power of excimer lasers are discussed.

41916 Dye laser probing of primary C_2 radicals formed by ir intense field photolysis of ethylene. Chekalin, N.V.; Dolzhikov, V.S.; Letokhov, V.S.; Lokhman, V.N.; Shibanov, A.N. (AN SSSR, Moscow. Inst. Spektroskopii). *Appl. Phys.;* **12**: No. 2, 191-195(Feb 1977).

5 figs.; 5 refs.

The C_2-radicals in the lower electronic state a^3 Pisub(u) have been studied by the method of laser-excited luminescence of products of ethylene ir photolysis. The dependence of C_2-radical concentration on IR field power density and its time evolution have been investigated. The threshold characteristics of C_2-radical occurrence and the ratio between excited and unexcited radicals have been determined. Different mechanisms for their formation are being discussed.

41917 Characteristics of CO_2 TE-amplifiers with different uv preionization at superatmospheric pressure with doping additives. Huebner, H.; Homann, C. (Technische Univ. Hannover (Germany, F.R.). Inst. fuer Plasmaphysik). *Appl. Phys.;* **12**: No. 2, 211-212(Feb 1977).

3 figs.; 7 refs.

The attainable maximum pressure and the small signal gain are compared at pressures up to 3 bar in a TE-CO_2 laser amplifier with two preionization systems. It is found that doping with tripopylamine increases the attainable pressure for glow discharges but decreases the small signal gain. At slightly superatmospheric pressure and low doping amount the simple Lamberton-Pearson device gives the best results. For constant input energy the inversion grows with increasing total pressure.

HEAT TRANSFER AND FLUID FLOW

REFER ALSO TO CITATION(S) 41270, 41312, 41343, 41418, 41453, 41458, 41459, 41464, 41531, 41545, 41546, 41547, 41549, 41550, 41552, 41553, 41554, 41593

41918 Heat transfer in the entrance section of a pipe with a two-phase flow. Kapinos, V.M.; Slitenko, A.F.; Chirkin, N.B.; Povolotskiy, L.V. *Heat Transfer - Sov. Res.;* **7**: No. 2, 126-128(1975).

The heat transfer in the entrance section of a vertical circular pipe, through which there is a flow of air bearing suspended drops of a fluid, was investigated. It was found that the pipe length required for heat transfer stabilization is 30d, assuming an average heat transfer coefficient. An empirical relationship is derived to permit calculation of the heat transfer in the accelerating section.

41919 Fabricating closed channels by electroforming. Johnson, H.R.; Dini, J.W. (Sandia Lab, Livermore, CA). *Plat. Surf. Finish.;* **62**: No. 5, 456-461(May 1975).

Three techniques for producing closed channels by electroplating are described-namely, plating in channels, the diffusion technique, and plating across open channels. These techniques permit closed channels of different sizes to be created. Openings as small as 0.0013 in. dia. have been fabricated with the plating-in-channels method, and continuous channels smaller than this could possibly be created with the diffusion technique. Where large channels are required, the plating-across-open-channels technique can be used.

41920 Mathematical model for cross-flow-induced vibrations of tube rows. Chen, S.S. (Argonne National Lab., IL). pp 415-426 of In Third international conference on pressure vessel technology. I. Analysis, design, and inspection. New York; American Society of Mechanical Engineers (1976).

A mathematical model is presented for cross-flow-induced vibrations of tube banks including the effects of vortex shedding, fluidelastic coupling, drag force, fluid inertia coupling, and others. The model can predict the following details of complex tube-fluid interactions: natural frequencies and mode shapes of coupled vibrations; critical flow velocities; responses to vortex shedding, drag force, and other types of excitations; and the dominant excitation mechanism at a given flow velocity. The analytical results are in good agreement with the published experimental results.

SAFETY ENGINEERING

41921 Friction loss studies using a 0.0127-m fire hose. Purington, R.G. (Univ of Calif, Lawrence Livermore Lab). *Fire Technol.;* **11**: No. 3, 184-190(Aug 1975).

The study described involved a novel injection system and the use of a 0.0127-m rubber hose, which is used for grass fire fighting at Lawrence Livermore Laboratory. The injection system developed involves the deposition of polyethylene oxide on Hexcel honeycomb. The honeycomb is inserted in the water stream where the polyethylene oxide is abraded by the water flow. The reduced data are presented.

ELECTRONIC CIRCUITS AND DEVICES

REFER ALSO TO CITATION(S) 41862

SOLID WASTE PROCESSING PLANTS AND EQUIPMENT

REFER ALSO TO CITATION(S) 41690, 42074

COMBUSTION SYSTEMS

41922 (AD-A—034537) **An investigation of ducted, two-stream, variable-density, turbulent jet mixing with recirculation. Final report, 23 May 1975—30 Jun 1976.** Schulz, R.J. (Arnold Engineering Development Center, Arnold Air Force Station, Tenn. (USA)). Jan 1977. 88p. (AEDC-TR—76-152). NTIS, PC A05/MF A01.

Prepared in cooperation with ARO, Inc., Tullahoma, Tenn., Rept. No. ARO-ETF-TR—76-80.

An investigation was conducted of two-stream, variable-density, turbulent jet mixing with recirculation confined within an axisymmetric duct that simulated a combustor configuration. The recirculating flow fields in the combustor simulator were the result of coaxial jet mixing between a central, primary air stream with a velocity of about 650 ft/sec and an annular secondary stream of hydrogen with velocities of 13, 23, or 48 ft/sec, depending on the desired test conditions. Experimental measurements are presented of radial distributions of time-averaged axial velocity and hydrogen mass fraction, axial distributions of time-averaged static pressure on the duct wall, axial velocity on the duct centerline, and hydrogen mass fraction on the duct wall and on the duct centerline. A theoretical study of the experimental flows was also conducted using a finite difference numerical solution technique for the calculation of viscous, recirculating flows. Comparison of theory and experiment shows that the predictive technique and the turbulence transport model require further development before accurate prediction of recirculating turbulent flows can be realized.

41923 Recent design concepts for coal firing. Reidick, H. (Energ und Verfahrenstech, Stuttgart, Ger). *VGB Kraftwerkstech.;* **55**: No. 7, 435-446(Jul 1975). (In German).

Design studies for steam generators with capacities of 900 to 1200 MW, depending on the type of fuel, are in progress in the Federal Republic of Germany. Considerations have so far identified no limitations arising from technical conditions. Detailed experience with 600 MW units is needed to provide knowledge of other design factors, such as availability. Data are presented in graphical and tabular form.

UNDERGROUND ENGINEERING

REFER ALSO TO CITATION(S) 41589, 41590, 41591, 41592, 41593, 41594, 41595, 41596, 41633

PARTICLE ACCELERATORS

BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS

41924 (AD-A—034613) **Faraday cup with multiple internal filters and a primary current monitor for characterizing high dose pulsed electron beams. Final report.** Childers, K.; Shea, J. (Physics International Co., San Leandro, Calif. (USA)). Oct 1976. Contract F29601-75-C-0123. 77p. (PIFR—835). NTIS, PC A05/MF A01.

Report on Diagnostic Development.

A Faraday cup with multiple internal filters has been developed for characterizing intense pulsed electron beams. Four points on the charge deposition profile can be obtained on a single pulse. These data, in conjunction with the diode voltage history and Monte Carlo electron transport calculations, can be used to establish the average transverse beam energy (mean angle of incidence) and hence the energy deposition profile. Performance of the device was demonstrated for a 5kJ, 600keV beam that was transported from the diode using longitudinal magnetic fields and that produced peak doses in excess of 200 cal/gm. A primary current monitor was also developed. This thin foil device, which is inserted between the diode and a target, measures the transported primary beam current passing through the foils, but not the low energy beam plasma return current. The present design caused attenuation of on the order of one-third of the beam energy. Three beam conditions obtained on the Model 225W Pulserad were characterized using these devices. The data confirm the absence of electron albedo in magnetically transported beams. Data obtained to investigate the effects of apertures on beam behavior indicate that apertures of 0.5-inch diameter or less lead to current waveforms that differ from the total current.

STORAGE RINGS

41925 (BNL—22237) **Possible effects of lowering the periodicity in ISABELLE.** Parzen, G. (Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract EY-76-C-02-0016. 3p. Dep. NTIS, PC A02/MF A01.

The replacement of one or more of the standard insertions by either a low-β or high-β insertion will reduce the periodicity of ISABELLE, with resulting effects on the particle dynamics. Some of the possible dynamics effects are listed and discussed.

INSTRUMENTATION

RADIATION INSTRUMENTATION

GENERAL DETECTORS AND MONITORS

REFER ALSO TO CITATION(S) 41936, 42013

41926 (AD-A—026905) **Carbon ribbon gauge for electron beam diagnostics. Final report.** Keller, D.V.; Rice, D.A.; Stretanski, E.D. (Ktech Corp., Albuquerque, N.Mex. (USA)). May 1976. Contract F29601-75-C-0084. 102p. (Ktech-TR—75-19). NTIS $5.50.

Large carbon and graphite monofilaments have been investigated for applications as an in-line diagnostic for pulsed electron beam irradiations of materials. The energy absorbed by the carbon ribbon causes a change in resistance which is measured a few microseconds after energy deposition. The measurement is therefore completed before there are any thermal losses or before the ribbon is broken by debris (from either specimen or anode materials). Both laboratory resistance and pulsed electron beam heating tests were made on carbon and graphitized carbon ribbon, and on Poco graphite rods. The first two materials survived doses up to 2000 cal/g; their resistance decreased with energy and they are suitable as a beam diagnostic up to 800 cal/g specific energy, above which their resistance change was insensitive to energy deposition. The Poco graphite resistance decreases by about 40% at doses of 200—400 cal/g, then increases at about 2—3% per 100 cal/g. This material would be a suitable beam monitor for doses from 400 cal/g to 1200 cal/g, and probably to 1700 cal/g and above. Additional work is required relating resistance change for these materials to absorbed ribbon dose, and determination of the maximum dose for which the Poco graphite can be used.

41927 (EGG—1183-2331) **Measurement of scintillation decay times for NE-111 and NE-102 fluors.** Sandifer, C.W.; Crandall, D.G. (EG and G, Inc., Santa Barbara, Calif. (USA)). Nov 1975. Contract EY-76-C-08-1183. 77p. Dep. NTIS $5.00.

A state of the art system for measuring the prompt and long decay components of selected fluors was assembled and calibrated. Measurements were conducted on both the fluor decay system and the EG and G/ERDA linear accelerator for comparison of the systems. Extensive results are reported for NE-111 and NE-102 fluors under various experimental conditions. The data have been tabulated and stored, and the system is maintained in operating condition for use in the LASL detector program.

41928 (N—76-27550) **Gas scintillation proportional counter for x-ray astronomy.** Andresen, R.D.; Taylor, B.G.; Sanford, P. (European Space Research and Technology Centre, Noordwijk (Netherlands)). 1975. 4p. NTIS, PC A02/MF A01.

Conf-Presented at the 14TH Intern. Cosmic Ray Conf., Munich, 15-29 Aug. 1975.

A transparent parallel plate xenon gas scintillation proportional counter was designed and built using ultra-high vacuum technology. This X-ray detector should achieve improved resolution by eliminating the charge multiplication stage. In order to use such a detector for space research it is highly desirable to eliminate any gas flow purification system. A new concept was therefore developed which uses a Ce-getter and does not depend on the presence of wavelength shifters. The preliminary experimental results, which are comparable to that achieved with an ordinary wire gas counter, demonstrate that this new concept is feasible. With a better light collecting geometry, which was deliberately not optimized in this first prototype, significant improvement is possible.

41929 (N—76-30527) **Fabrication of a focusing soft x-ray collector payload. Final report, 22 Nov 1972—30 Jun 1976.** Davis, J.M.; Decaprio, A.R.; Manko, H.; Ting, J.W.S. (American Science and Engineering, Inc., Cambridge, Mass.). 30 Jun 1976. Contract NASW-2292. 44p. (NASA-CR—144804; ASE—3857). NTIS $4.00.

A large area X-ray focusing collector with arc minute resolution and a position sensitive detector capable of operating in the soft X-ray region was developed for use on sounding rockets in studying stellar X-ray sources. The focusing payload consists of the following components, which are described: (1) a crossed paraboloid mirror assembly; (2) an aspect camera and star tracker; (3) a focal plane assembly containing an imaging proportional counter and its preamplifiers, high voltage power supplies and gas system; (4) a fiducial system; and (5) housekeeping, data handling, instrumentation and telemetry electronics. The design, tests, and operation are described.

41930 (PB—257833) **S^3 solid state proton experiment. Part II. Mean energy of a finite energy passband. Technical memo.** McKinnon, J.A.; Fritz, T.A. (National Oceanic and Atmospheric Administration, Boulder, Colo. (USA). Space Environment Lab.). Apr 1976. 48p. (NOAA-TM-ERL-SEL—44). NTIS, PC A03/MF A01.

General expressions for the differential energy passbands of solid state detector experiments carried as instrumentation on spacecraft are presented. Although this class of detector has its passbands determined electronically, it is well represented mathematically by the cumulative distribution function of the familiar gaussian curve. Expressions for the detector response, response ratio, and mean energy are developed for any particle passband of arbitrary but finite width and have been numerically evaluated by assuming an exponential form for the particle energy spectrum. The derived general relationships have been applied to the low and high energy passbands of the Solid State Proton Experiment on board Explorer 45 (S sup 3), and the results are presented in graphical and tabular form.

RADIATION DOSEMETERS

REFER ALSO TO CITATION(S) 42093, 42095, 42096, 42097, 42098, 42099, 42100, 42101, 42102, 42103, 42104, 42105, 42106, 42107, 42108, 42109, 42110, 42111, 42112, 42113, 42114

HIGH ENERGY PHYSICS INSTRUMENTATION

41931 (CRN-HE—76-15) **Study of a particle detector with very high spatial precision (drift chambers), and analysis of the physical phenomena governing the operation of this detector.** Schultz, G. (Strasbourg-1 Univ., 67 (France). Centre de Recherches Nucleaires; Strasbourg-1 Univ., 67 (France)). 1976. 214p. (In French). Dep. NTIS (US Sales Only), PC A10/MF A01.

Thesis.

The physical principles of drift chambers are studied and various measurements which can be performed with these chambers are described. The laws governing the passage of particles through matter are first reviewed and different transport coefficients, (velocity, scattering coefficient, characteristic energy ...) of the electrons under the influence of an electric field for different gases (argon, CO_2, isobutane, methane, methylal) are studied. The theoretical predictions are then compared with the experimental results. The different amplification processes in the gas and the space charge effect of the positive ions on electron multiplication for large particle fluxes are also studied as well as the mobility of positive ions in different gases. After these results, the operating characteristics (efficiency, linearity of the space-time ratio, spatial resolution), with and without an external magnetic field are determined.

RADIATION EFFECTS ON INSTRUMENT COMPONENTS, INSTRUMENTS, OR ELECTRONIC SYSTEMS

41932 (AD-A—027047) **Internal interaction analysis: topological concepts and needed model improvements. Final report.** Tesche, F.M.; Morgan, M.A.; Fishbine, B.; Parkinson, E.R. (Science Applications,

Inc., Berkeley, Calif. (USA)). May 1976. Contract F29601-75-C-0112. 35p. NTIS, PC A03/MF A01.

This report introduces and formalizes various topological concepts for defining internal interaction problems. A preliminary examination of presently-used internal interaction models is made, and indications of possible improvements are given. Finally, a brief discussion of possible statistical approaches to the internal interaction problem is presented.

41933 (AD-A—034425) **Interface states in Schottky barrier diodes. Interim report.** Borrego, J.M.; Gutmann, R.J. (Rensselaer Polytechnic Inst., Troy, N.Y. (USA). Dept. of Electrical and Systems Engineering). Aug 1976. Contract F19628-74-C-0102. 101p. NTIS, PC A06/MF A01.

The electrical behavior of Schottky barrier junctions before and after neutron irradiation have been explored. Guarded Au/nGaAs diodes were fabricated from bulk and epitaxial material with a preirradiation n factor of 1.03 and saturation current density of 10 to the minus 8th power amps/sq cm. After irradiation with low neutron fluences (i.e., carrier removal less than 10%) the reverse current increased by one to two orders of magnitude with only a slight increase in n factor. I-V and C-V measurements from 77K to 360K and photoelectric measurements at room temperature were taken in developing an understanding of the effect of neutron irradiation on the electrical characteristics of these Schottky barrier diodes (including with transient ionizing radiation). The experimental results have been interpreted from an interface state density model as suggested by Levine. The results of this model have been compared to those reported by Levine and Crowell and Roberts with unirradiated diodes. The limitations of interpreting the results using the interface state density model have been delineated experimentally. Calculations indicate that current from field-enhanced emission is present in addition to thermionic emission current from the interface state model. Implications of these results on the use of Schottky junction devices in neutron radiation environments are presented.

41934 (AD-A—034791) **EMP preferred test procedures (selected electronic parts). Revision.** Bridges, J.E.; Emberson, W.C.; Nanda, V.P.; Wells, W.C.; Peach, L.C. (IIT Research Inst., Chicago, Ill. (USA)). Sep 1976. Contracts DNA001-72-C-0089;DNA001-73-C-0149. 322p. (IITRI-E—6230-Rev.; IITRI-E—6261-Rev.). NTIS, PC A14/MF A01.

Revision of report dated 29 Aug 1974, Rept. No. DNA—3286H, AD—787482.

EMP preferred test procedures are provided to evaluate and characterize the performance of a number of electrical devices. Topics covered are experiment design, documentation, typical induced EMP transients, and the specific test procedures to evaluate the EMP behavior for each type of electronic component.

41935 (N—76-28223) **Irradiate-anneal screening of total dose effects in semiconductor devices.** Stanley, A.G.; Price, W.E. (Jet Propulsion Lab., Pasadena, Calif. (USA)). 15 Jul 1976. Contract NAS7-100. 38p. (NASA-CR—148487; JPL-TM—33-788). NTIS $4.00.

The research was carried out as part of a program to harden Mariner Jupiter/Saturn 1977 (MJS' 77) spacecraft to survive the Jupiter radiation belts. The method consists of irradiating devices with Cobalt-60.

41936 (N—76-30279) **Low fluxes of x rays. Final report.** (Teledyne Brown Engineering, Huntsville, Ala. (USA). Systems Analysis Dept.). Feb 1976. Contract NAS8-26342. 8p. (NASA-CR—149984; MS-MSFC—1975). NTIS $3.50.

Analytic and experimental investigations of the interactions of high-energy protons with spacecraft materials and light nucleus atoms were conducted. Irradiation of typical materials for scintillation detectors using accelerator-produced energetic protons and associated theoretical calculations indicate activity within detectors produced by this mechanism is significant to detection of low-level cosmic gamma radiation. Samples of several materials were flown aboard Skylab to obtain measures of the neutron and proton flux environment. Extremely weak activity was produced in the samples. Calculations of interactions of intermediate-energy protons with light nuclei were performed, and a more nearly complete theoretical model was programed for digital computation. Preliminary results appear promising for calculating products of such interactions. (auth)

MISCELLANEOUS INSTRUMENTS

REFER ALSO TO CITATION(S) 40748, 40759, 40983, 41414, 41415, 42015, 42184

41937 (CONF-770201—2) **Thermoluminiminescent dosimeters (TLD's) used to monitor temperature exposure.** Romberg, G.P.; Prepejchal, W. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 8p. Dep. NTIS, PC A02/MF A01.

From 5. international conference on luminescence dosimetry; Sao Paulo, Brazil (14 Feb 1977).

A technique has been developed for using pre-irradiated TLD's to measure temperature exposure. This "thermal dosimetry" is based on the loss or "fade" of stored TL signal at a rate proportional to temperature such that the total accumulated fade provides a measure of the past accumulated temperature exposure. Requirements for the effective use of this technique are discussed in relation to practical experience gained in using $CaSO_4$:Mn to monitor average environmental water temperatures and the thermal exposure of individual fish.

41938 (UCRL—78339(Rev.1)) **Computer-based transportable data-acquisition and control system.** Fisher, D.K.; Posehn, M.R.; Sindelar, F.L.; Bell, H.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Sep 1976. Contract W-7405-ENG-48. 12p. (CONF-761062—9). Dep. NTIS, PC A02/MF A01.

From 47. shock and vibration symposium; Albuquerque, New Mexico, United States of America (USA) (19 Oct 1976).

A computer-based transportable data-acquisition and control system for use in laboratory physical testing has been developed through a top-down design approach. The principal characteristics of the resulting system are a versitle process interface, sophisticated on-line data reduction, and ease of programming. Applications have included thermocouple data acquisition, holographic interferometry, impulse-response testing, and vibration shaker cntrol.

WELL LOGGING INSTRUMENTATION

REFER ALSO TO CITATION(S) 42143

41939 **Recent developments in the direct interpretation of resistivity soundings.** Koefoed, O. (Delft Univ of Technol, Neth). *Geoexploration;* **14**: No. 3-4, 243-250(Oct 1976).

The application of the direct interpretation of resistivity soundings using the resistivity transform, has in practice encountered the difficulty that absurd results may be obtained, such as negative resistivity values. An analysis of this phenomenon has led to the conclusion that it is causally related to the error magnification that occurs in the process of reducing to a lower boundary plane. The magnitude of the error magnification depends on the ratio of the coordinates of a point of the transform curve to the parameters of the layer that is being removed. Insight into this relation makes it possible to avoid the difficulties in the direct interpretation method by a combination of two measures: (a) not to apply the reduction to parts of the transform curve where the error magnification is too large; (b) to compute the limits of reliability of the reduced transform in the marginal section of the transform curve. Another development is described: the derivation of an approximate interpretation method which is based upon the fundamental equations of the direct interpretation method, but which is applied directly to the apparent resistivity curve.

EXPLOSIONS AND EXPLOSIVES

CHEMICAL

41940 (UCID—17379) **Generalized shaped charge design. Final report, October 1975—October 1976.** Van Thiel, M.; Godfrey, C.S.; Wilkins, M.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 Feb 1977. Contract W-7405-ENG-48. 62p. (BRL—266-76). Dep. NTIS, PC A04/MF A01.

A series of shaped charge devices were designed and tested. The tests showed that by combining detailed Lagrange calculations of liner collapse with simplified incompressible flow models, the explosive and liner contours of the charge can be tailored to yield either constant velocity jets, stretching jets, or converging jets. Measured liner velocity was within 10 percent of theory, except for details near the apex and close to slide planes. It was found that the effects of liner convergence and viscosity had to be included in the incompressible flow models to accurately correlate liner velocity, collapse angles, and jet velocity.

41941 (UCRL—77305(Rev.1)) **Measuring small internal pressures along a tube during steady flow.** Freynik, H.S.; Dittbenner, G.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 16 Mar 1977. Contract W-7405-ENG-48. 23p. (CONF-760541—2). Dep. NTIS, PC A02/MF A01.

From Meeting of the Society for Experimental Stress Analysis; Washington, District of Columbia, United States of America (USA) (9 May 1976).

A tube that can accurately measure small strains and pressure profiles during flow of non-Newtonian paste explosives has been designed and strain gaged. Equiangular rosette strain gages were installed along the length of a 6-mm-dia, 0.46-m-long thin-walled aluminum tube. The rosettes were oriented in the classical stress-gage configuration to measure circumferential stress and hence internal pressure independent of other stresses. The tube was static calibrated on a floating-piston pressure calibrator. Steady flow calibration was accomplished by extruding a viscous Newtonian silicone oil. Inlet pressure ranged from 0.52 to 2.1 MPa (75 to 300 psi). For the low-pressure 0.52-MPa silicone oil extrusion, the full-scale strain levels varied from 6 to 53 μm/m. For all eight strain gage stations, the maximum deviation from a linear pressure profile was equivalent to 0.5 μm/m. A pulsed current excitation signal-conditioning and digital data-acquisition system provided the necessary stability and precision to measure these unusually low strain levels accurately.

41942 Rapid heating-to-ignition of high explosives. I. Friction heating. Randolph, A.D.; Hatler, L.E.; Popolato, A. (Los Alamos Scientific Lab., NM). *Ind. Eng. Chem., Fundam.;* **15**: No. 1, 1-6(Feb 1976).

A friction ignition model was developed that predicts the thermal decomposition of condensed phase explosive when impacted at an oblique angle on rigid target surfaces. The model was verified by the experimental initiation behavior of pressed hemispherical billets of PBX 9404 subjected to an oblique impact on targets with widely varying thermal conductivities. The explosive was impacted on targets of fused quartz, aluminum oxide, and gold with similar surface characteristics. The experimentally determined estimates of the drop heights required to produce an explosive event ranged over two orders of magnitude, with the high conductivity gold target and the low conductivity quartz target being, respectively, the least and most sensitive. These results were satisfactorily explained with the thermal ignition model by computer simulation of the mechanical and thermal events occurring during the oblique impact leading to ignition of the charge. No attempt was made to calculate the buildup from ignition to detonation.

NUCLEAR

41943 (AD-A—029389) **NOVA-2: a digital computer program for analyzing nuclear overpressure effects on aircraft. Part 2. Computer program. Final report.** Lee, W.N.; Mente, L.J. (Kaman Avidyne, Burlington, Mass. (USA)). Aug 1976. Contract F29601-75-C-0032. 155p. (KA-TR—128-Pt-2). NTIS, PC A08/MF A01.

See also AD-A029388.

NOVA-2 (Nuclear Overpressure Vulnerability Analysis, Version 2) is an updated version of NOVA, a FORTRAN-4 digital computer program for calculating the response of individual structural elements of aircraft, such as stringers, frames and panels, exposed to the transient pressure loading associated with the blast wave from a nuclear explosion. The updated version extends the capability of NOVA to analyze rib elements, frames with variable cross section, and offers a choice of clamped, simply supported or free edge boundary conditions.

CIVIL USES

REFER ALSO TO CITATION(S) 41039, 41040

WEAPONRY

41944 (AD-A—034399) **AFWL Technical Objective Number 4, nuclear systems support. FY 1978. Final report, Jan 1977—Jan 1978.** Collier, W.D. (Air Force Weapons Lab., Kirtland AFB, N.Mex. (USA)). Dec 1976. 16p. (AFWL-TR—76-234). NTIS, PC A02/MF A01.

Every US Air Force aircraft and missile system with a nuclear capability must be conceived, developed, built, and operated in accordance with nuclear safety standards. The Air Force must assure itself that systems being developed with a nuclear capability or which might potentially operate in a nuclear environment have characteristics that are compatible with design, safety, and operational requirements of the Air Force. Air Force regulations and ERDA DOD agreements provide for the systematic integration of safety features into Air Force nuclear systems during all phases of development, acquisition, and operational employment. ERDA must be provided with criteria, requirements, and guidance on nuclear bomb/warhead development and integration with specific delivery systems to ensure compatibility with Air Force systems.

41945 (PB—257702) **Ready I system for the UNIVAC 1108 summary analysis program.** (General Services Administration, McLean, Va. (USA). Mathematics and Computation Lab.). Jun 1976. 144p. (GSA/FPA/MCL-TM—233). NTIS, PC A07/MF A01.

See also AD-772142.

The summary analysis program, part of the Ready I System, is to be used in producing edited listings from the output of the Ready I Weapons Effects Program. The listings provide a summary of the damage, accessibility, casualty, and dose effects experienced by selective groups of resource points. The program also has the capability to provide binary output for use by other programs.

EXPLOSION DETECTION

41946 (AD-A—034769) **Vela network evaluation and automatic processing research. Quarterly report No. 5, 10 Jul—10 Oct 1976.** Turnbull, L.S. Jr. (Texas Instruments, Inc., Dallas (USA)). 10 Oct 1976. Contract F08606-76-C-0011. 8p. (TI-ALEX—(01)QR-76-05). NTIS, PC A02/MF A01.

Work in the following areas is summarized: array and network evaluation; signal detection methods; signal estimation techniques; and discrimination.

41947 (AD-A—034883) **Applications of higher mode surface waves. Technical report.** Lane, S.S. (Texas Instruments, Inc., Dallas (USA)). 8 Oct 1976. Contract F08606-76-C-0011. 30p. (TI-ALEX—(01)-TR-76-10). NTIS, PC A03/MF A01.

Report on VELA Network Evaluation and Automatic Processing Research.

Amplitudes of first higher mode Love waves from seismic events in North America were measured on the North American continent and corrected for attenuation, structure, and distance. The corrected amplitudes were fitted to a source model to estimate the source depth. The high value of the attenuation coefficient and lack of a good seismic model prevented good agreement between known and calculated depths. In order to estimate the effect of the seismic source structure, the ratio of the first higher mode to fundamental Love wave amplitudes was found experimentally and compared to the theoretical prediction. Agreement was better than for the spectral fitting method but was still short of being satisfactory.y

41948 (AD-A—034897) **Network capability estimation. Vela network evaluation and automatic processing research. Technical report.** Snell, N.S. (Texas Instruments, Inc., Dallas (USA)). 24 Sep 1976. Contract F08606-76-C-0011. 62p. (TI-ALEX—(01)-TR—76-04). NTIS, PC A04/MF A01.

NETWORTH is a computer program which calculates the detection and location capability of seismic networks. A modified version of NETWORTH has been developed. This program has been used to evaluate the effect of station 'downtime', the signal amplitude variance, and the station detection threshold upon network detection capability. In this version all parameters may be changed separately for individual stations. The capability of using signal amplitude corrections has been added. The function of amplitude corrections is to remove possible bias in the magnitude estimate due to inhomogeneous signal attenuation. These corrections may be applied to individual stations, individual epicenters, or individual station/epicenter combinations. An option has been added to calculate the effect of station 'downtime' upon network capability. This study indicates that, if capability loss due to detection errors can be minimized, then station detection threshold and station reliability will be the fundamental limits to network performance. A baseline network of thirteen stations has been performed. These stations are as follows: Alaskan Long Period Array, (ALPA); Ankara, (ANK); Chiang Mai, (CHG); Korean Seismic Research Station, (KSRS); Large Aperture Seismic Array, (LASA); Mashhad, (MSH); Mundaring, (MUN); Norwegian Seismic Array, (NORSAR); New Delhi, (NWDEL); Red Knife, Ontario, (RK-ON); Shillong, (SHL); Taipei, (TAP); and White Horse, Yukon, (WH-YK).

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 41011, 41950, 42000, 42001, 42002

41949 (ANL—75-60(Pt.4), pp 47-50) **Generalized Kolmogorov—von Karman relation and some further implications on the magnitude of the constants.** Frenzen, P. 1975.

In Radiological and Environmental Research Division annual report. Part IV. Atmospheric physics.

The relation between the Kolmogorov and von Karman constants in the atmospheric surface boundary layer appropriate to the special conditions of neutrally stratified and locally dissipating flow is essentially a straightforward combination of the logarithmic wind profile, the one-dimensional spectral relation for turbulent

energy density in the inertial subrange, and a reduced turbulent energy equation that balances the dissipation rate with a mechanical production term alone. The effects of the stability-dependent, dimensionless wind shear, the diabatic wind profile (an integral of the above), on the complete energy equation are discussed.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 40862, 40986, 41281, 41987, 42085, 42117, 42118, 42119, 42120, 42121, 42124, 42125, 42127

41950 (ANL—75-60(Pt.4)) **Radiological and Environmental Research Division annual report. Part IV. Atmospheric physics. January—December 1975.** (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-ENG-38. 101p. Dep. NTIS, PC A06/MF A01.

Separate abstracts were prepared for 15 sections of this report that reports research studies on meteorological parameters affecting air pollution and the environmental transport of pollutants. A list is included of papers published during the time period covered by this report. (CH)

41951 (ANL—75-60(Pt.4), pp 1-4) **PBL structure: the Sangamon Experiment of 1975.** Hess, G.D.; Hicks, B.B. 1975.

In Radiological and Environmental Research Division annual report. Part IV. Atmospheric physics.

The environmental impact of a number of fossil-fuel power plants in Illinois was investigated using numerical models of air pollution effects for a regional analysis. As a part of this study a field study (the Sangamon Experiment) was conducted during 1975 to examine physical mechanisms in the planetary boundary layer (PBL). This experiment was coordinated with the Midwest Interstate Sulfur Transformation and Transport (MISTT) project to investigate the effects of the urban plume emanating from St. Louis at distances of up to 100 km. Results are reported from studies on the evolution of the PBL capping inversion between the hours of 0400 and 1200; micrometeorological studies over maize and soybean crops growing in the area; measurements of wind speed, turbulence, and temperature in the lowest 100 m of the atmosphere; and measurements of the concentration of ozone, sulfur dioxide, nitrogen dioxide, and hydrocarbons in air samples from a kytoon system.

41952 (ANL—75-60(Pt.4), pp 5-9) **Preliminary look at the diurnal behavior of the PBL.** Hess, G.D.; Sisterson, D.L.; Hicks, B.B.; Miller, E.L. 1975.

In Radiological and Environmental Research Division annual report. Part IV. Atmospheric physics.

Atmospheric factors that govern the dispersion and transport of air pollutants discussed include the behavior of the planetary boundary layer (PBL) during the morning hours, beginning before the sun rises; the influence of surface heating after the sun rises on erosion of the base of the nocturnal inversion; and the influence wind speed and height and temperature on mixing throughout the boundary layer. It is pointed out that many of the processes occurring within the PBL must be parameterized in numerical models rather than being directly calculated since they occur on scales smaller than the resolution of the models.

41953 (ANL—75-60(Pt.4), pp 10-15) **PBL scaling using surface flux information.** Hess, G.D.; Hicks, B.B. 1975.

In Radiological and Environmental Research Division annual report. Part IV. Atmospheric physics.

The role of the atmospheric planetary boundary layer (PBL) in the transport and dispersion of air pollutants is discussed. It is pointed out that because the physical processes controlling the structure in the lowest one to two km of the atmosphere can be complex, interpretation of observational data is often ambiguous. The value of similarity theory for interpreting experimental data and for designing field experiments is discussed.

41954 (ANL—75-60(Pt.4), pp 16-21) **Sangamon Experiment: geostrophic wind profiles.** Lipschutz, R.C. 1975.

In Radiological and Environmental Research Division annual report. Part IV. Atmospheric physics.

Methods used for the direct measurement of geostrophic wind profiles to complement measurements of planetary boundary layer structure are described. It is pointed out that the direct estimation of geostrophic wind profiles involves an atmospheric flow situation in which friction and accelerations are not important but that high quality pressure and temperature data are required and that, in addition to calibration errors and human errors in taking the measurements, local climate and terrain characteristics of each station may affect the date.

41955 (ANL—75-60(Pt.4), pp 22-30) **Measurements of atmospheric turbidity in an arc downwind of St. Louis.** Wesely, M.L. 1975.

In Radiological and Environmental Research Division annual report. Part IV. Atmospheric physics.

A preliminary analysis of the data obtained with use of the dichopyranometer indicates that large decreases in the direct-beam irradiance occurred during August 9 - 11 at several of the monitoring sites, four of which were located on an arc about 110 km from the Gateway Arch, Jefferson Expansion National Memorial, a well-known landmark in St. Louis. The four sites have azimuthal bearings east of north from the Arch of —16 deg (EPA, Glasgow), 9 deg (Waverly), 24 deg (Sangamon Co.), and 31 deg (Sloman farm). There are figures that show the variation of four-hour averages of tau at these sites. Also shown are the turbidity measurements at the St. Louis site, which was actually in Illinois at RAMS site 103, located about 7 km northeast of the Gateway Arch in a suburban area. The urban plume from St. Louis was expected to be about 20 deg wide and perhaps 10 to 20 deg greater in azimuth than the surface wind direction would indicate. Thus, on August 8, the effects of the plume should have been detected at the site on the azimuthal bearing of 24 deg, but this was not evident from the data. On August 9, the plume should have been east of, or at a greater azimuthal bearing than, the easternmost site (at 31 deg), and this may be supported by the existence of the slightly greater values of turbidity at that easternmost site. However, on August 10 and 11, similar southwesterly wind directions were not always associated with a maximum in turbidity at the easternmost site. Hence, it appears that the St. Louis plume did not consistently have a dominant role in causing atmospheric turbidity.

41956 (ANL—75-60(Pt.4), pp 31-33) **Pressure-sensitive release mechanism for radiosonde applications.** Kulhanek, F.C. 1975.

In Radiological and Environmental Research Division annual report. Part IV. Atmospheric physics.

As part of the 1975 planetary boundary layer field experimental program, miniature radiosondes attached to pilot balloons were released into the atmosphere for routine sampling of the vertical temperature distribution. A new releasing mechanism used to continue sampling during descent by parachute is described.

41957 (ANL—75-60(Pt.4), pp 34-36) **Structure of the urban moisture field.** Sisterson, D.L.; Dirks, R.A. 1975.

In Radiological and Environmental Research Division annual report. Part IV. Atmospheric physics.

In the 26 July 1974 case study in St. Louis as a part of Project METROMEX, aircraft and surface network stations were used to determine specific humidity and potential temperature patterns near the surface and at two levels within the mixing layer. From the data acquired at these three levels, three-dimensional analyses of the moisture fields in the mixing layer were constructed. The mesoscale dry regions observed throughout the mixing layer correspond to the more impervious surfaces of the urban area. From energy budget considerations, latent heat fluxes are small over these impervious surfaces owing to the large runoff of precipitation and the lack of moisture retention capabilities. Hence, urbanization obviously alters the local energy budget. Surface boundary layer conditions are determined by heat and moisture fluxes. A new internal boundary layer within the city is formed after the breakdown of the radiation inversion in order to compensate for the alteration of sensible heat and latent heat energies. Hence, isolated semistagnant urban air is replenished by moisture only as quickly as evapotranspiration from impervious surfaces will allow. The city surface, therefore, is not a sink of moisture, but rather a reduced source relative to rural areas.

41958 (ANL—75-60(Pt.4), pp 37-41) **Application of a lagrangian statistical trajectory model to the simulation of sulfur pollution over the northeastern United States.** Sheih, C.M. 1975.

In Radiological and Environmental Research Division annual report. Part IV. Atmospheric physics.

A regional-scale model of pollutant transport and dispersion was used to simulate sulfur pollution over the northeastern United States. Application of the model to the simulation of pollution by sulfur dioxide from 53 major fossil-fuel power plants for the month of April, 1971, resulted in the ranges of 0.6 to 5.2 $\mu g\ m^{-3}$ for sulfate concentration and 0.16 to 1.4 $g\ m^{-2}\ yr^{-1}$ for sulfur dry deposition. The results also showed that within the area of interest about 25 percent of the total sulfur emitted into the atmosphere was deposited on the ground through dry deposition, and the general pattern of the sulfate concentration was shifted several hundred kilometers eastward from the sources.

41959 (ANL—75-60(Pt.4), pp 42-46) **Puff-on-cell model for computing pollutant transport and diffusion.** Sheih, C.M. 1975.

In Radiological and Environmental Research Division annual report. Part IV. Atmospheric physics.

Most finite-difference methods of modeling pollutant dispersion have been shown to introduce numerical pseudodiffusion, which can be much larger than the true diffusion in the fluid flow and can even generate negative values in the predicted pollutant concentrations. Two attempts to minimize the effect of pseudodiffusion are discussed with emphasis on the particle-in-cell (PIC) method of Sklarew. This paper describes a method that replaces Sklarew's numerous particles in a grid volume, and parameterizes subgrid-scale

concentration with a Gaussian puff, and thus avoids the computation of the moments, as in the model of Egan and Mahoney by parameterizing subgrid-scale concentration with a Guassian puff.

41960 (ANL—75-60(Pt.4), pp 51-57) **Instrumental requirements for the measurement of pollutant fluxes.** Hicks, B.B. 1975.

In Radiological and Environmental Research Division annual report. Part IV. Atmospheric physics.

Numerical models that include dry deposition at the surface as a sink for atmospheric contamination usually parameterize this surface flux by means of a deposition velocity which relates the surface flux to the appropriate concentration of material in air at various heights. Although it can be argued that this type of formulation hides too many critical factors in its simplicity, more realistic methods for formulating F/sub c/ do not appear to be as attractive from the viewpoint of numerical simulation. Thus, there is considerable incentive to improve our knowledge of v/sub d/, preferably through carefully-controlled field experiments, especially in order to determine values appropriate over the long times and large distances which are of interest in regional scale simulations. Experimental evaluations of deposition velocity are becoming more common, particularly in the chemically interesting cases of SO_2 and O_3. Some of the experimental requirements imposed by the turbulent properties of the atmosphere that are involved in the deposition process are discussed, with emphasis on the accuracy and drifts of sensors suitable for measuring gradients.

41961 (ANL—77-13) **Environmental monitoring at Argonne National Laboratory. Annual report for 1976.** Golchert, N.W.; Duffy, T.L.; Sedlet, J. (Argonne National Lab., Ill. (USA)). Mar 1977. Contract W-31-109-ENG-38. 86p. Dep. NTIS, PC A05/MF A01.

The results of the environmental monitoring program at Argonne National Laboratory for 1976 are presented and discussed. To evaluate the effect of Argonne operations on the environment, measurements were made for a variety of radionuclides in air, surface water, Argonne effluent water, soil, grass, bottom sediment, and foodstuffs; for a variety of chemical constituents in surface and Argonne effluent water; and of the environmental penetrating radiation dose. Sample collections and measurements were made at the site boundary and off the Argonne site for comparison purposes. Some on-site measurements were made to aid in the interpretation of the boundary and off-site data. The results of the program are interpreted in terms of the sources and origin of the radioactive and chemical substances (natural, fallout, Argonne, and other) and are compared with accepted environmental quality standards. The potential radiation dose to off-site population groups is also estimated.

41962 (N—76-24681) **Use of LARS system for the quantitative determination of smoke plume lateral diffusion coefficients from ERTS images of Virginia.** Blais, R.N.; Copeland, G.E.; Lerner, T.H. (Old Dominion Univ., Norfolk, Va. (USA). Dept. of Physics and Geophysical Sciences). 1975. Contract NGL-47-003-067. 13p. (NASA-CR—148137). NTIS $3.50.

A technique for measuring smoke plume of large industrial sources observed by satellite using LARSYS is proposed. A Gaussian plume model is described, integrated in the vertical, and inverted to yield a form for the lateral diffusion coefficient, Ky. Given u, wind speed; y sub l, the horizontal distance of a line of constant brightness from the plume symmetry axis a distance x sub l, downstream from reference point at x=x sub 2, y=0, then K sub y = u ((y sub 1) to the 2nd power)/2 x sub 1 ln (x sub 2/x sub 1). The technique is applied to a plume from a power plant at Chester, Virginia, imaged August 31, 1973 by LANDSAT I. The plume bends slightly to the left 4.3 km from the source and estimates yield Ky of 28 sq m/sec near the source, and 19 sq m/sec beyond the bend. Maximum ground concentrations are estimated between 32 and 64 ug/cu m. Existing meteorological data would not explain such concentrations. (Author)

41963 (N—76-29382) **Hybrid computer program for rapidly solving flowing or static chemical kinetic problems involving many chemical species.** Mclain, A.G.; Rao, C.S.R. (National Aeronautics and Space Administration, Langley Station, Va. (USA). Langley Research Center). Jul 1976. 102p. (NASA-TM-X—3403;L—10768). NTIS, PC A06/MF A01.

A hybrid chemical kinetic computer program was assembled which provides a rapid solution to problems involving flowing or static, chemically reacting, gas mixtures. The computer program uses existing subroutines for problem setup, initialization, and preliminary calculations and incorporates a stiff ordinary differential equation solution technique. A number of check cases were recomputed with the hybrid program and the results were almost identical to those previously obtained. The computational time saving was demonstrated with a propane-oxygen-argon shock tube combustion problem involving 31 chemical species and 64 reactions. Information is presented to enable potential users to prepare an input data deck for the calculation of a problem.

41964 (N—76-29738) **Meteorological adjustment of yearly mean values for air pollutant concentration comparison.** Sidik, S.M.; Neustadter, H.E. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Jul 1976. 43p. (NASA-TN-D—8253;E—8628). NTIS $4.00.

Using multiple linear regression analysis, models which estimate mean concentrations of Total Suspended Particulate (TSP), sulfur dioxide, and nitrogen dioxide as a function of several meteorologic variables, two rough economic indicators, and a simple trend in time are studied. Meteorologic data were obtained and do not include inversion heights. The goodness of fit of the estimated models is partially reflected by the squared coefficient of multiple correlation which indicates that, at the various sampling stations, the models accounted for about 23 to 47 percent of the total variance of the observed TSP concentrations. If the resulting model equations are used in place of simple overall means of the observed concentrations, there is about a 20 percent improvement in either: (1) predicting mean concentrations for specified meteorological conditions; or (2) adjusting successive yearly averages to allow for comparisons devoid of meteorological effects. An application to source identification is presented using regression coefficients of wind velocity predictor variables.

41965 (PB—255277) **Evaluation of SO_2 emission control technology applicable to the East Helena lead smelter. Final report.** Weisenberg, I.J. (Pacific Environmental Services, Inc., Santa Monica, Calif. (USA)). Jan 1975. Contract EPA-68-02-1354. 103p. NTIS $5.50.

Contents: Lead smelter operations generating SO_2 and particulate; Sulfuric acid plant technology; Lead smelters with sulfuric acid plant SO_2 control; Sulfuric acid plant operation with lead sinter machine problems and solutions; SO_2 control for ASARCO lead smelter, East Helena, Montana; References. (GRA)

41966 (PB—255288) **National air sampling network. Status report.** Levene, B. (Environmental Protection Agency, Denver, Colo. (USA). Region VIII). 1975. 31p. NTIS $4.00.

This report presents a region-wide summary of air monitoring sites which are part of the National Air Sampling Network (NASN). The network in Region VIII consists of fifteen sites, all of which contain one high volume sampler to measure total suspended particulate, and seven of which have, in addition, gas bubblers to measure ambient concentrations of SO_2 and NO_2. Since January 1974, the EPA Regional Office in Denver has been responsible for network operation, maintenance, and calibration of equipment. The operators of the sites are volunteers from the Forest Service, National Park Service, or State or local air pollution agencies. All necessary supplies, including filters and bubblers, are sent to the operators by the EPA Regional Laboratory and samples are returned to the Laboratory after sampling has occurred. Samples are run from midnight to midnight (24-hours) on the days indicated by the 6-day sampling schedule (see Appendix B). The Laboratory analyzes the samples according to standard methods and reports concentrations in micrograms per cubic meter of air (microgram/cu m). Twice each year, EPA personnel inspect the sites, replace worn equipment and calibrate the instruments. Further analyses are done on every other filter from each site by EPA. Filters are analyzed for nitrates, sulfates, ammonia, and organics. Data obtained is contained in this report. (GRA)

41967 (PB—255313) **Regional air pollution study: quality assurance audits. Final report.** Hibar, J.R. (Rockwell International Corp., Creve Couer, Mo. (USA). Air Monitoring Center). Jun 1976. Contract EPA-68-02-1081. 45p. NTIS $4.00.

Aerometric data is being collected by the Regional Air Pollution Study (RAPS) for use in developing and evaluating air quality simulation models. In addition to the Regional Air Monitoring System (RAMS), data is also collected by research teams in periodic expeditions to the St. Louis study area. Data from all sources are made available for integration through the RAPS Data Bank. A quality assurance audit of instrument systems employed in the Summer 1975 RAPS Expeditionary Research Program was conducted to check the various systems for accuracy. Additionally such checks provide a basis for determining the extent to which data from different instrument systems may be integrated. This report describes the audit equipment and standards used and problems encountered. Quantitative audit results from individual instrument systems are presented. The audits included analyzers for NO, NOX, SO_2, SO_2, CO, CH_4 and THC measurements. (GRA)

41968 (PB—255730) **Air quality models required data characterization. Final report.** Sklarew, R.C.; Wilson, J.C. (Science Applications, Inc., Westlake Village, Calif. (USA)). May 1976. 75p. NTIS $4.50.

Prepared in cooperation with Xonics, Inc., Van Nuys, Calif.

The objective of this study, on project 677-1, was to develop a document to aid in the design of research programs to furnish sufficient data for evaluation of air quality plume modeling. This major objective was met by assembling, primarily through the use of questionnaires sent throughout the modeling community, the input parameter requirements of a majority of current plume models. From the responses of forty-four air quality modeling groups a

rather complete picture emerged of current models and their input requirements as well as of developing directions. From the survey it is clear that most models have been constructed to use data which can be readily obtained. (GRA)

41969 (PB—256004) **Area source emission inventory for Dougherty County, Georgia. Volume I.** Ungers, L.J. (PEDCO-Environmental Specialists, Inc., Cincinnati, Ohio (USA)). Dec 1975. Contract EPA-68-02-1375. 116p. NTIS $5.50.

Sponsored in part by Georgia Dept. of Natural Resources, Atlanta. Environmental Protection Div. See also Volume 2, PB—256005.

This project was undertaken to prepare an inventory of area sources of particulate matter, SOx, CO, HC, and NOx emissions in the Albany area for use in analysis and modeling of air quality in this designated Air Quality Maintenance Area for the period 1975-85. Base year (1973) emissions are projected to 1975, 1980 and 1985, as specified in EPA's regulations governing the preparation of Air Quality Maintenance Plans. Total emissions in thirty categories, including fugitive dust, were allocated into grid squares covering the entire area. The emissions for each grid were estimated by use of EPA's 'Area-2 Program'. Required input data for this program, aside from pertinent grid information are fuel usage totals and emission factors. Volume 1 describes the procedures and discusses the data obtained. (GRA)

41970 (PB—256204) **Growth effects of major land use projects: Volume III. Summary. Final report.** Benesh, F.H.; Guldberg, P.; D'Agostino, R. (Abcor, Inc., Cambridge, Mass. (USA). Walden Research Div.). Sep 1976. Contract EPA-68-02-2076. 249p. (C—781-c). NTIS $8.00.

SEe also Volume 2, PB—255302.

The report discusses a research program whose goal is to formulate a methodology to predict air pollutant emissions resulting from the construction and operation of two types of major land use projects, large residential projects and large concentrations of employment. Emissions are quantified from the major project, from land use induced by the major project, from secondary activity occurring off-site (i.e., generation of electricity by utilities), and from motor vehicle traffic associated with both the major project and its induced land uses. This volume provides a summary of the first two volumes, viz. the specification and causal analysis of the land use model and the development of the land use based emission factors. It also discusses the development of the predictive equations in the land use model and the development of the traffic model. (GRA)

41971 (PB—257706) **Utility of reactivity criteria in organic emission control strategies. Application to the Los Angeles atmosphere. Final report.** Trijonis, J.C.; Arledge, K.W. (TRW/Environmental Services, Redondo Beach, Calif. (USA)). Aug 1976. Contract EPA-68-02-1735. 236p. NTIS $8.00.

This report investigates the impact of reactivity criteria on organic emission control strategies in the Metropolitan Los Angeles Air Quality Control Region. The investigation involved assembling data on total organic emission rates, on organic emission composition, and on emission reactivity for the Los Angeles basin. On the basis of this data, calculations were then made of the degree to which each emission source type should be controlled to achieve the air quality standard for ozone/oxidant. Results were obtained and compared for the cases of indiscriminate control and of selective, reactivity-based control. (GRA)

41972 (PB—257891) **Reaction kinetics of ozone with sulfur compounds. Final report.** Erickson, R.E.; Yates, L.M. (Montana Univ., Missoula (USA). Dept. of Chemistry). Aug 1976. 70p. NTIS $4.50.

The report presents data on the reaction between ozone and several sulfur compounds which are air pollutants. The compounds of interest are sulfur dioxide, dimethyl sulfide, methanethiol and dimethyl disulfide. The rate of the reaction between ozone and dissolved sulfur dioxide is strongly pH dependent. This is so because sulfite ion reacts extremely rapidly (second order rate constant four orders of magnitude higher than that of bi-sulfite ion). These results suggest that under some conditions atmospheric oxidation of sulfur dioxide may involve ozone. Dimethyl sulfide was found to react extremely rapidly with ozone in the gas phase but reproducible kinetic data were not obtained. Stoichiometric and yield data from the reaction between ozone and methanethiol or dimethyl disulfide in aqueous solution indicate those reactions to be complex mechanistically, although one product, methane sulfonic acid is predominant.

41973 (PB—258137) **Area source emission inventory: Hamilton County, Tennessee, and Walker and Catoosa Counties, Georgia. Volume I.** (PEDCO-Environmental Specialists, Inc., Cincinnati, Ohio (USA)). Oct 1975. Contract EPA-68-02-1375. 141p. NTIS $6.00.

This report is an inventory of area sources of air pollutant (TSP, SOx, CO, HC, NOx) emissions in three counties in the Chattanooga area for use in analysis and modeling of air in this AQMA for the period 1975 to 1985. Total pollutant emissions are summarized by category for the base year and three projection years. Survey data, emission estimating procedures, and projection techniques used in this report are presented in detail for each source category. Volume 1 presents a summary of the data obtained. (GRA)

41974 (PB—258138) **Area source emission inventory: Hamilton County, Tennessee, and Walker and Catoosa Counties, Georgia. Volume II.** (PEDCO-Environmental Specialists, Inc., Cincinnati, Ohio (USA)). Oct 1975. Contract EPA-68-02-1375. 249p. NTIS $8.00.

This report is an inventory of area sources of air pollutant (TSP, SOx, CO, HC, NOx) emissions in three counties in the Chattanooga area for use in analysis and modeling of air in this AQMA for the period 1975 to 1985. Volume 2 is a tabulation of observed and predicted emissions by source category, grid number, and pollutant apportionments. (GRA)

41975 (PB—261917) **Technology and economics of flue gas NO/sub x/ oxidation by ozone. Final report, Jul—Oct 1976.** Harrison, J.W. (Research Triangle Inst., Durham, N.C. (USA)). Dec 1976. Contract EPA-68-02-1325. 74p. NTIS, PC A04/MF A01.

The report gives results of an investigation of the kinetics of oxidation of NO by ozone and concludes that a stoichiometric amount of ozone is required when oxidation occurs at flue gas temperatures typical for electrical generating stations. It also surveys the state of current technology for large-scale ozone generation and concludes that electrical discharge is the only feasible method at present. The report also presents results (on a per unit basis) of calculations of the energy consumption and economics of ozone generation at rates sufficient to oxidize NO at flue gas flow rates and at nitrogen oxides (NO/sub x/) concentrations typical for 500 MW coal- and oil-fired boilers. Stationary combustion sources contribute about half the manmade NO/sub x/ emitted to the atmosphere in the U.S. Flue gas from combustion processes contains NO/sub x/ which is predominantly in the form of NO. Although NO_2 is to some extent soluble in water or aqueous solutions, NO is practically insoluble when conventional scrubbing processes are used. For effective removal, the NO must either be reduced to elemental nitrogen or oxidized to NO_2 or higher oxides which can be removed by scrubbing.

41976 (PB—261922) **Desulfurization of steel mill sinter plant gases. Final report.** Brown, G.D.; Coleman, R.T.; Dickerman, J.C.; Lowell, P.S. (Radian Corp., Austin, Tex. (USA)). Oct 1976. Contract EPA-68-02-1319. 215p. NTIS, PC A10/MF A01.

The report gives results of an evaluation of the technical and economic feasibility of using limestone scrubbing technology to control sinter plant emissions. Data from Soviet and Japanese sinter plants employing limestone scrubbing technology were used to develop a realistic design basis. A conceptual process design was developed and used to prepare economic estimates. Results of the process design indicate that control of sinter plant emissions by limestone scrubbing is technically feasible. Economic evaluations show that limestone scrubbing will increase the cost of producing sinter by about $1.82 per metric ton of product sinter for a standard sinter plant operation. For a sinter plant with a windbox gas recirculation system, the cost increase would be about $1.44 per metric ton of product sinter.

41977 (PB—262002) **Source assessment: glass container manufacturing plants. Final report, Sep 1975—Sep 1976.** Schorr, J.R.; Hooie, D.T.; Sticksel, P.R.; Brockway, C. (Battelle Columbus Labs., Ohio (USA)). Oct 1976. Contract EPA-68-02-1323. 146p. NTIS, PC A07/MF A01.

The report summarizes results of a study to gather and analyze background information and technical data related to air emissions from glass container manufacturing operations. It covers emissions from three plant areas: raw materials preparation and handling, glass melting, and forming and finishing operations. Melting furnace emissions account for over 95 percent of the total plant emissions. The major pollutants are NO/sub x/, SO/sub x/, and submicron particulates consisting mainly (over 90 percent) of mineral sulfates. Source severity factors determined by this study were 0.38 for NO/sub x/, 0.56 for SO/sub x/, and 0.035 for particulates, with others being less than 0.01. Source severity is a measure of the potential environmental effect of air emissions and is the ratio of the maximum average ground level concentration to the primary ambient air quality standard for criteria pollutants.

41978 (PB—262092) **Determination of the feasibility of ozone formation in power plant plumes. Volume I. Executive summary.** Ogren, J.A.; Blumenthal, D.L.; White, W.H.; Tesche, T.W.; Yocke, M.A. (Meteorology Research, Inc., Altadena, Calif. (USA)). Nov 1976. 37p. NTIS, PC A03/MF A01.

Prepared in cooperation with Systems Applications, Inc., San Rafael, Calif.

Meteorology Research, Inc., Systems Applications, Inc. and the University of Washington Cloud Physics Group have conducted investigations of the potential for ozone formation in the plumes of

coal- and gas-fired power plants in the southwestern United States. The studies included a review of pertinent scientific literature, collection of extensive air quality and meteorological data by two aircraft at three southwestern power plants, analysis of the data, and testing of a computer simulation model for chemically reactive plumes. The primary finding of all investigators is that no net ozone formation attributable to the power plant plume was observed in the field data at any location. However, the simulation model predicts that a 10-15% increase in ambient ozone may occur when background hydrocarbon concentrations are high. This prediction suggests that greater emphasis must be placed in future field programs on accurately measuring ambient hydrocarbons.

41979 (PB—262093) **Determination of the feasibility of ozone formation in power plant plumes. Volume II. Final report.** Ogren, J.A.; Blumenthal, D.L.; White, W.H.; Tesche, T.W.; Yocke, M.A. (Meteorology Research, Inc., Altadena, Calif. (USA)). Nov 1976. 399p. NTIS, PC A17/MF A01.

See also Volume 1, PB—262092. Prepared in cooperation with Systems Applications, Inc., San Rafael, Calif.

Contents: Introduction; Program description; Summary of results--(Results of literature study, Field masurement studies and data analysis, Reactive plume model validation study, Reactive plume model (RPM) sensitivity study, RPM case studies, References); Conclusions and recommendations; Review of literature relevant to the study of ozone formation in plumes--(Overview, The photochemistry of power plant plumes, Field studies of power plant plumes, Mathematical models of power plant plumes, References); Field programs--(Objective, Site selection, Plant description, Preliminary model study, Sampling protocol, Description of parameters measured, Chronology of field programs, References); Data processing and reduction--(Aircraft data, Meteorological data, Ultraviolet radiation data, Sulfate data, Hydrocarbon data, Plant operating data, Data volume, References); Field data analysis; Reactive plume model validation study--(Overview, Validation data base, Comparison of model predictons and measurements, Detailed validation studies, Appraisal of the validity of RPM, References); RPM sensitivity study--(Overview, Methodology of the sensitivity study, Variable screening exercise, Determination of RPM sensitivities to the remaining four variables, Assessment of results, Summary, References); Further RPM studies--(Introduction, Temporal variation in solar radiation, Consideration of alternative kinetic mechanisms, The role of ambient carbon monoxide, Ozone formation in power plant plumes, Summary, References); Existing needs in the observational and analytical study of plumes.

41980 (PB—262094) **Determination of the feasibility of ozone formation in power plant plumes. Volume III. Data summary.** Ogren, J.A.; Blumenthal, D.L.; White, W.H.; Tesche, T.W.; Yocke, M.A. (Meteorology Research, Inc., Altadena, Calif. (USA)). Nov 1976. 399p. NTIS, PC A17/MF A01.

See also Volume 2, PB—262093. Prepared in cooperation with Systems Applications, Inc., San Rafael, Calif.

Contents: Introduction; Data collection and processing; Explanation of tables and figures; Symbols and abbreviations; Instrument status survey.

41981 (PB—262095) **Determination of the feasibility of ozone formation in power plant plumes. Volume IV. Data summary.** Ogren, J.A.; Blumenthal, D.L.; White, W.H.; Tesche, T.W.; Yocke, M.A. (Meteorology Research, Inc., Altadena, Calif. (USA)). Nov 1976. 586p. NTIS, PC A25/MF A01.

See also Volume 3, PB—262094. Prepared in cooperation with Systems Applications, Inc., San Rafael, Calif.

Contents: Flight outline; Aircraft sampling routes; Weather summary; Weather map; Pibal data; Pibal location map; Ultraviolet radiation data; Ultraviolet radiation stripchart; Sulfate data; Hydrocarbon data; Plant load data; Aircraft data plots.

41982 (PB—262096) **Determination of the feasibility of ozone formation in power plant plumes. Volume V. Data summary.** Ogren, J.A.; Blumenthal, D.L.; White, W.H.; Tesche, T.W.; Yocke, M.A. (Meteorology Research, Inc., Altadena, Calif. (USA)). Nov 1976. 408p. NTIS, PC A18/MF A01.

See also Volume 4, PB—262095. Prepared in cooperation with Systems Applications, Inc., San Rafael, Calif.

Contents: Daily Weather Summary, October 15, 1975; Daily Weather Map, October 15, 1975; Flight outline; Aircraft sampling routes; Weather summary; Weather map; Pibal data; Pibal location map; Ultraviolet radiation data; Ultraviolet radiation stripchart; Sulfate data; Hydrocarbon data; Plant load data; Aircraft data plots.

41983 (UCD—472-123, pp 11-14) **Collaborative efforts in the characterization of stack-collected fly ash.** Fisher, G.L.; Prentice, B.A.; Silberman, D.; Ondov, J.M.; Ragaini, R.C.; Bierman, A.H. 1976.

In Annual report, fiscal year 1976.

A collaborative study with Lawrence Livermore Laboratory (LLL) has been initiated to characterize the physical and chemical properties of stack-collected fly ash. The expertise of the two laboratories with respect to chemical analysis and particle sizing is complementary and allows for comparison and extension of analytical results not possible with independent analysis.

41984 **Value of stabilizers in the determination of sulphur dioxide in the air.** Gentilizza, M.; Fugas, M.; Valic, F. *Arh. Hig. Rada Toksikol.;* **25**: No. 1, 27-32(1974). (In Serbo-Croatian).

The efficacy of adding stabilizers (5 percent glycerol, 0.2 percent normal-butanol, and 0.5 percent acacia) to 0.01 molar sodium hydroxide for the collection and storage of airborne sulfur dioxide samples was investigated. Good collection efficiency was obtained for mixtures of SO_2 and air prepared in the laboratory; however, poor results were obtained with realistic air samples due to the presence of nitrogen dioxide in the atmosphere. Although the stabilizers protected SO_2 oxidation by oxygen, they were ineffective in preventing nitrogen dioxide-induced oxidation of SO_2. Thus, the stabilizer absorption medium is not recommended for ambient air sampling.

41985 **Gas chromatographic analysis of air pollutants.** Morimoto, S. *Idemitsu Sekiyu Gijutsu;* **18**: No. 1, 18-41(1975). (In Japanese).

The gas chromatographic method with high sensitivity and selectivity is widely used for the analysis of environmental pollutants. Detectors such as flame ionization detectors, flame photometric detectors, electron capture detectors (ECD), FTD and others are described with characteristics of each and schematic diagrams. As for column packing materials, the lists of commercially available stationary liquid phase material and solids coated with nonvolatile stationary liquid are given in tabular form. The general analysis procedures for microamounts of malodorants, aldehyde in automotive exhaust gas, polycyclic aromatic hydrocarbons, benzopyrene in suspended particulates, peroxyacyl nitrate, polychlorinated biphenyls, alkylmercury compounds, cyanides, and agricultural chemicals are described with sampling methods and equipment, measurement conditions, data, and evaluation method of data. Gas chromatography is used not only for organic compounds but also inorganic compounds and metal complexes.

41986 (PB—254560-T/SL) **Report of a nationwide survey of photo-chemical smog using the morning glory as an indicator.** Jan 1975. Translation of Asagao ni Yoru Kokagaku Sumoggu Kansatsu Zengoku Chosa Kenkyu Hokoku. (EPA-TR—76-165). 100p. NTIS $5.00.

This survey and research was planned in order to grasp on a large scale the extent of spread across the nation of air pollution (which will be called simply photo-chemical smog) caused by photochemical reactions. The plan was to observe the leaves of the morning glory for the appearance of visible damage caused by oxidants and ozone which are secondary products of the photochemical reaction. The results of the study showed that injuries caused by oxidants were found on the indicator plants in regions reaching all the way from Miyagi prefecture in the north to Kagoshima prefecture in the south along the Pacific coast, all over Shikoku, and in Niigata and Toyama prefectures along the coast of the Japan Sea. Through this survey many Junior High School students, who hold the destiny of the next generation, experienced recognition of photo-chemical smog and the extent to which it causes damage to the plants.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 41961, 42085

41987 (HASL—318(App.)) **Appendix to health and safety laboratory environmental quarterly.** (Energy Research and Development Administration, New York (USA). Health and Safety Lab.). 1 Apr 1977. 580p. Dep. NTIS, PC A18/MF A01.

Data are tabulated on: the content of ^{90}Sr and ^{89}Sr in monthly deposition at monitoring sites in the USA and other locations throughout the world; the content of ^{90}Sr in milk samples collected in New York City; the content of ^{137}Cs and ^{90}Sr in samples of drinking water collected in New York City; and the content of fallout radionuclides and lead in samples of surface air collected at various world sites during 1976. (CH)

41988 (N—76-24799) **Characteristics of natural radioactivity appearing in its diurnal variation.** Nakatani, S. (Electrotechnical Lab., Tokyo (Japan)). Oct 1975. 75p. (REPT—755). NTIS $4.50.

The characteristics of naturally occurring radioactivity were investigated in terms of the time variation of its concentration in the atmosphere. An outline of various types of time variation of the concentration of radioactivity occurring naturally in the atmosphere is presented along with methods of measuring the properties of natural radioactivity, especially the nature of size distributions of radioactive aerosols and the degree of equilibrium between radon-

222 and its daughters in the air which are influenced by various conditions of the atmosphere. The first reason for the study was the need for investigation of the nature of airborne radioactivity that produces various effects on ionization and electric phenomena. Secondly, the concentration of the natural background activity occurring in Tokyo is important in view of the anticipated rise in activity level due to the use of various radioisotopes. In addition the effect of radioactive aerosols on the human body has attracted the attention of many researchers. The size distribution of radioactive aerosols and the degree of radioactive equilibrium among the radon daughters are closely related to the magnitude of the internal radiation doses.

THERMAL EFFLUENTS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 41484, 41499

REGULATIONS

REFER ALSO TO CITATION(S) 41597

41989 (PB—254274) **Compilation of air pollutant emission factors. Supplement Number 6. Second edition.** (Environmental Protection Agency, Research Triangle Park, N.C. (USA). Office of Air Quality Planning and Standards). Apr 1976. 59p. (AP—42-Suppl-6). NTIS $4.50.

See also report dated Dec 1975, PB—249526.

In this supplement for Compilation of Air Pollutant Emission Factors (AP-42) revised and updated emissions data are presented for fuel oil combustion, open burning, heavy-duty, natural-gas-fired pipeline compressor engines, alfalfa dehydrating, sugar cane processing, natural gas processing, and woodworking operations.

41990 (PB—255101) **Environmental quality profile, 1976. Alaska, Oregon, Idaho, Washington. Final report.** (Environmental Protection Agency, Seattle, Wash. (USA). Region X). 1976. 28p. (EPA—910/9-76/026). NTIS $4.00.

This document provides an overview of the environmental quality of EPA's Region X - Alaska, Idaho, Oregon, and Washington. It is intended to help develop an overall perspective on environmental issues as well as to assist in policy analysis, program management, and program evaluation. All the basic data came from annual reports submitted by the states to EPA. (GRA)

41991 (PB—255218) **North Carolina air quality maintenance area analysis. Volume I. TSP area source emission inventories for Charlotte, Winston-Salem, and Greensboro AQMA's for 1973, 1975, 1980, and 1985. Final report.** (Engineering-Science, Inc., McLean, Va. (USA)). Apr 1976. Contract EPA-68-02-1380. 100p. NTIS $5.00.

See also PB—255219. Prepared in cooperation with North Carolina Dept. of Natural and Economic Resources, Raleigh. Div. of Environmental Resources.

This report gives the results of the work done by Engineering-Science, Inc. in support of the air quality maintenance analysis for North Carolina. This work fell into four stages: (1) update of the 1973 baseline year emission inventory; (2) allocation of the baseline year emission inventory to subcounty and/or air quality display model grid squares; (3) projection of county or subcounty emission inventories to 1975, 1980, and 1985; and (4) allocation of the projected emission inventories to subcounty and/or air quality display model grid squares. Fifteen categories of area source emissions were listed and projected. (GRA)

41992 (PB—257892) **Guideline for public reporting of daily air quality: Pollutant Standards Index (PSI). Final report.** Hunt, W.F. Jr; Ott, W.R.; Moran, J.; Smith, R.; Thom, G. (Environmental Protection Agency, Research Triangle Park, N.C. (USA). Office of Air Quality Planning and Standards). Aug 1976. 44p. (EPA—450/2-76/013;OAQPS—1.2-044). NTIS $4.00.

The U.S. EPA's Pollutant Standard Index (PSI) is the result of a joint effort on the part of EPA's Offices of Air and Waste Management, Research and Development, and Planning and Management. The guideline suggests the use of an air quality index for those local and state air pollution control agencies wishing to report an air quality index on a daily basis. The PSI places maximum emphasis on protecting the public health; that is, it advises the public of any possible adverse health effects due to pollution. The index incorporates five major pollutants: carbon monoxide, oxidants, particulates, sulfur dioxide, and nitrogen dioxide. 'Good' air quality falls in the 0 to 50 range, 'moderate' air quality from 50 to 100, 'unhealthful' from 100 to 200, 'very unhealthful' from 200 to 300, and 'hazardous' above 300. (GRA)

41993 (PB—257975) **Standards support and environmental impact statement. Volume 1. Proposed standards of performance for petroleum refinery sulfur recovery plants.** (Environmental Protection Agency, Research Triangle Park, N.C. (USA). Emission Standards and Engineering Div.). Sep 1976. 200p. (EPA—450/2-76/016a). NTIS $7.50.

A national emission standard for sulfur dioxide and reduced sulfur compound emissions from petroleum refinery sulfur recovery plants is being proposed under authority of section 111 of the Clean Air Act. Sulfur dioxide is a criteria pollutant whose adverse effects are well documented. Reduced sulfur compound emissions could reach ambient levels sufficient to produce severe odor problems in the vicinity of a petroleum refinery in the absence of the standard. The purpose of the proposed standard is to minimize reduced sulfur and sulfur dioxide emissions from refinery sulfur recovery plants to the level attainable with best available control technology. The standard will have the effect of reducing emissions from a typical refinery sulfur recovery plant by 99.9%. Environmental impact and economic impact statements quantifying the impacts of the proposed standard and alternative control options are included in the document. (GRA)

ENVIRONMENTAL SCIENCES, TERRESTRIAL

BASIC STUDIES

REFER ALSO TO CITATION(S) 41594, 41595

41994 (RLO—2225-T36-1) **Ecology of intertidal benches of Amchitka Island, Alaska. Final summary report, August 1, 1974—December 31, 1974.** Palmisano, J.F.; O'Clair, C.E.; Nakatani, R.E. (Washington Univ., Seattle (USA). Fisheries Research Inst.). 23 May 1975. Contract EY-76-S-06-2225. 11p. Dep. NTIS, PC A02/MF A01.

A comparison of western Aleutian Islands with and without sea otters shows this species to be important in determining the nearshore community at Amchitka. Sea otters control herbivorous invertebrate populations and indirectly affect wave exposure and the composition of the rocky intertidal community. Removal of sea otters causes increased herbivory and ultimately results in destruction of macrophyte (algae) associations. The observations suggest that a dense sea otter population indirectly supports island fauna associated with macrophyte primary productivity.

41995 **Nitrogen isotope discrimination in denitrification of nitrate in soils.** Blackmer, A.M.; Bremner, J.M. (Iowa State Univ., Ames). *Soil Biol. Biochem.*; **9**: No. 2, 73-77(1977).

Nitrogen isotope discrimination during denitrification in soils of nitrate containing natural concentrations of ^{14}N and ^{15}N was studied by determining the amount and the ^{15}N content of nitrate-N and (nitrate + nitrite)-N in nitrate-treated soils incubated under anaerobic conditions (He atmosphere) for various times after treatment with glucose to promote denitrification. Analyses performed showed that the nitrite-N lost on incubation of these soils could largely be accounted for as products of denitrification (nitrite, NO, N_2O and N_2). The studies reported show that marked discrimination between ^{14}N and ^{15}N occurs during denitrification of nitrate in soils and that significant N isotope effects occur both in reduction of nitrate to nitrite and in reduction of nitrite to gaseous forms of N. They also indicate that the overall N isotope effect during denitrification of nitrate in soil will depend upon the tendency of the soil to accumulate nitrite under conditions that induce denitrification. It is concluded that discrimination between ^{14}N and ^{15}N during denitrification in soils of nitrate containing natural concentrations of these isotopes is of sufficient magnitude to invalidate the use of N isotope-ratio analyses for assessment of the contributions of soil and fertilizer N to nitrate in surface or ground waters or to nitrous oxide in the atmosphere.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 41961, 42117

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 41961

41996 (PB—258257) **Report of ambient outdoor radon and indoor radon progeny concentrations during November 1975 at selected locations in the grants mineral belt, New Mexico. Final technical note.** Eadie, G.G.; Kaufmann, R.F.; Markley, D.J.; Williams, R. (Environ-

mental Protection Agency, Las Vegas, Nev. (USA). Office of Radiation Programs). Jun 1976. 53p. (ORP/LV—76-4). NTIS $4.50.

This report presents the results of measurements of ambient outdoor radon concentrations and indoor radon progeny working level determinations during November 1975 for 10 locations throughout the Ambrosia Lake area and vicinity, New Mexico. For that portion of the study area in the vicinity of uranium mines and mills, statistical evaluation of the data indicates that ambient outdoor radon concentrations and the indoor radon progeny levels (WL) are in excess of typical background levels. Better definition of background levels and a more thorough evaluation of specific source terms in the immediate Ambrosia Lake area is strongly suggested. For locations in proximity to a uranium mill site, gamma radiation exposure rates and the radium-226 content of surface soils are also above normal background conditions. This may reflect the deposition of windblown tailings and/or ore dust. To assure compliance with State and Federal regulations, it is recommended that further studies be conducted over at least a one-year period for comparison to the applicable radiation protection guides for those areas in the vicinity of uranium mill sites. Radiation exposures to the general population occupying areas in the immediate vicinity of uranium mining and milling operations should also be evaluated. (GRA)

TERRESTRIAL ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 41987, 42085

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 40852, 40858, 40859, 40860, 40990, 41585, 41588, 41589, 41590, 41591, 41592, 41593, 41594, 41595, 41596, 41596, 41609, 41610, 41612, 41613, 41614, 41615, 41616, 41633, 41642, 41994, 42085

41997 (PB—255302) **Growth effects of major land use projects. Volume II. Compilation of land use based emission factors. Final report.** Benesh, F. (Abcor, Inc., Cambridge, Mass. (USA). Walden Research Div.). Jun 1976. Contract EPA-68-02-2076. 114p. (C—781-b). NTIS $5.50.

See also PB—255301.

Growth Effects of Major Land Use Projects is a research program whose goal is to formulate a methodology to predict air pollutant emissions resulting from the construction and operation of two types of major land use projects, large residential projects and large concentrations of employment (i.e., office parks and industrial parks). Emissions are quantified from the major project, from land use induced by the major project, from secondary activity occurring off-site (i.e., generation of electricity by utilities), and from motor vehicle traffic associated with both the major project and its induced land uses. This report documents the development of a set of land use based emission factors (i.e., emissions per unit of building floor area or per dwelling unit) that are used to estimate emissions from the induced land uses and secondary activities. To accomplish this, energy consumption in several categories of buildings is quantified. The emission sources may be principally categorized as follows: Stationary source emissions occurring on the site of the major project (e.g., the on-site combustion of fuel oil for space heating needs); stationary source emissions occurring at the land use induced by the major project (e.g., the on-site combustion of fuel oil for space heating needs); and secondary (i.e., occurring off-site) stationary source emissions (e.g., the combustion of fuel oil at the local electric utility to serve the electricity demand of the major project and induced land uses). (GRA)

41998 (PB—258279) **Criteria for developing pollution abatement programs for inactive and abandoned mine sites.** Robbins, J.D.; Hutchins, J.C. (Skelly and Loy, Harrisburg, Pa. (USA)). Aug 1975. Contract EPA-68-01-2655. 489p. NTIS $12.50.

This report involves the development of abatement criteria for all mined mineral commodities except oil and gas production, well sites and offshore mining. All abandoned or inactive surface and underground mines, attendant waste piles, road storage areas and other related facilities are included in the report. (GRA)

41999 (PB—258471) **Erosion and sediment control audiovisual training program instructor's workbook. Final report.** Mills, T.R.; Nawrocki, M.A.; Squire, G.R.; Hopkins, H.T.; Clar, M.L. (Maryland State Water Resources Administration, Annapolis (USA)). Jun 1976. 354p. NTIS, PC A16/MF A01.

See also PB—256901.

A series of technical presentations and a certification plan for erosion and sediment control specialists are presented. Thirteen lessons complete with visual aids, student handouts and audiovisual handouts consisting of slides, videotape and tape narration, workbooks and instructor's manuals are developed. These materials are designed to provide an effective education program for qualifying construction personnel and others to pass a certification examination.

REGULATIONS

REFER ALSO TO CITATION(S) 40861, 41597

ENVIRONMENTAL SCIENCES, AQUATIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 40789, 41950, 42147

42000 (ANL—75-60(Pt.4), pp 64-68) **Preliminary study of the relationship between surface and bulk water temperatures at the Dresden cooling pond.** Wesely, M.L.; Hicks, B.B.; Hess, G.D. 1975.

In Radiological and Environmental Research Division annual report. Part IV. Atmospheric physics.

Successful application of bulk aerodynamic formulae to determine the vertical sensible and latent heat fluxes above a cooling lake requires accurate estimates of water surface temperature. Because of the heat loss at the surface and partial insulation by the poorly-mixed outer skin of water in contact with the air-water interface, the surface temperature is usually 0.1 to 2.0 C less than the temperature at a depth greater than 1 cm. For engineering applications requiring estimates of the total heat dissipation capacity of a particular cooling lake, the bulk temperature of the entire mixed layer of subsurface water is more important than the surface temperature. Therefore, in order to simulate the thermal performance of a cooling pond, both the surface temperature and the bulk temperature should be estimated. In the case of cooling ponds, the total heat transfer through the uppermost layer is extremely large and the water beneath the surface is strongly mixed by circulation currents within the pond. The purpose of this report is to describe the magnitude of the temperature difference across the surface skin at the Dresden nuclear power plant cooling pond and to relate this difference to variables used in modeling the thermal performance of cooling ponds.

42001 (ANL—75-60(Pt.4), pp 69-75) **Examination of some bulk formulae used for assessing the performance of industrial cooling ponds.** Hicks, B.B.; Wesely, M.L. 1975.

In Radiological and Environmental Research Division annual report. Part IV. Atmospheric physics.

Earlier investigation of the magnitude of errors likely to occur in applying the usual expressions to data obtained at the shore of cooling ponds showed that none of the models is capable of predicting the short-term turbulent heat transfer with accuracy. The accuracy of several mathematical models are compared.

42002 (ANL—75-60(Pt.4), pp 76-80) **Preliminary tests of a model of cooling-pond thermal performance.** Hicks, B.B.; Wesely, M.L.; Wilczek, J. 1975.

In Radiological and Environmental Research Division annual report. Part IV. Atmospheric physics.

Experiments performed during recent years at the cooling pond complex at the Dresden nuclear power station have been designed to improve our understanding of the fundamental properties of thermal exchange at a warm-water surface. To a considerable extent, the field studies have been successful in that they have shown that modern micrometeorological techniques can be successfully applied to the demanding circumstances of an industrial cooling lake at temperature of at least 40°C. The intent of these studies has been to create a set of parameterization schemes good enough to allow simulation of the performance of the Dresden cooling lake without adjustment of numerical constants. An obvious extension of these studies, and one of the goals of the cooling-pond research program as presently stated, is to obtain an accurate numerical simulation of thermal performance of ponds with use of the improved formulations that have resulted from the experimental work at the Dresden lake. The computer model is divided into two sections and can be used to test the sensitivity of predicted performance to variations in procedures for determining the thermal transfer from the surface.

42003 (RLO—2227-T12-71) **Exchange of manganese, iron, copper, and zinc between dissolved and particulate forms in the Newport River estuary, North Carolina.** Evans, D.W. (Oregon State Univ., Corvallis (USA). School of Oceanography). 1976. Contract EY-76-S-06-2227. 234p. Dep. NTIS, PC A11/MF A01.

Thesis.

Exchange of manganese, iron, copper, and zinc between solution and particulate phases was studied in the Newport River estuary, North Carolina. Metal analyses were by flameless atomic absorption spectrophotometry, those in solution after concentration by Chelex-100 resin. Longitudinal sampling transects in the estuary in October, 1974, and February and April, 1975, showed trends of

dissolved metal concentrations versus salinity interpretable in terms of exchange of the metals between solution and particulate phases. A simple mixing model explained variations of dissolved metal concentrations within the estuary by river and seawater inputs and outputs and internal sources and sinks reflecting the exchange processes. Metal concentrations on suspended particulate matter provided corollary evidence of metal exchanges.

42004 **Decomposition in freshwater.** Saunders, G.W. (Energy Research and Development Administration, Washington, DC). pp 341-373 of In Role of terrestrial and aquatic organisms in decomposition processes. Anderson, J.M. (ed.). Oxford; Blackwell Scientific Publications (1976).

The following topics are reviewed: greater concentration of dissolved organic matter than particulate matter in lakes, streams, and oceans; chemical characteristics of particulate matter in freshwater; decomposition of particulate organic matter and leaf litter; role of fungi in decomposition of plant material; decomposition of dissolved organic matter; turnover times for glucose in various lake types; dynamics of dissolved organic matter decomposition; the chemical structure of organic matter released extracellularly by bacteria and phytoplankton; dynamics of particulate organic matter decomposition; and dynamics of decomposition processes in freshwater. (HLW)

RADIOMETRIC TECHNIQUES

42005 **Concentration of diatom frustules in Lake Michigan sediment cores.** Parker, J.I.; Edgington, D.N. (Argonne National Lab., IL). *Limnol. Oceanogr.;* **21**: No. 6, 887-893(Nov 1976).

The concentration of diatom frustules was determined in 14 sediment cores that were dated by ^{210}Pb and ^{137}Cs techniques. The concentration in the 0—0.5-cm sediment layer varied from 6.31×10^5 to 3.71×10^7 frustules g dry wt. The annual deposition of frustules to the sediment ranged from 7.00×10^3 to 5.20×10^5 frustules $cm^{-2}\,yr^{-1}$, less than 5 percent of the estimated annual diatom production based on average annual diatom standing crop, turnover rate, and depth of the euphotic zone. The vertical distribution of frustules in every core showed a logarithmic decrease of at least two orders of magnitude in a depth equivalent to 80—100 years B.P. Scanning electron photomicrographs of frustules from the sediment show evidence of dissolution. Dissolved silica concentrations in deep and interstitial water support the conclusion that diatom frustules are dissolving in both the water column and sediment. The permanent sediment is probably not a major sink for particulate biogenic silica in Lake Michigan.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 40854, 40855, 40983, 40988, 40989, 40993, 40994, 41027, 41961

42006 (N—76-28682) **Numerical modeling of pollutant transport using a Lagrangian marker particle technique.** Spaulding, M. (National Aeronautics and Space Administration, Langley Station, Va. (USA). Langley Research Center). Aug 1976. 35p. (NASA-TM-X—73930). NTIS, PC A03/MF A01.

A derivation and code was developed for the 3 dimensional mass transport equation, using a particle-in-cell solution technique, to solve coastal zone waste discharge problems where particles are the major component.

42007 (NTIS/PS—77/0027) **Water pollution analysis and detection. Volume 2. July 1974—January 1977 (a bibliography with abstracts). Report for Jul 1974—Jan 1977.** Lehmann, E.J. (National Technical Information Service, Springfield, Va. (USA)). Feb 1977. 171p. NTIS, PC N01/MF A01.

Supersedes NTIS/PS—76/0038 and NTIS/PS—75/156.

These cited studies cover water analysis techniques, including gas chromatography, mass spectroscopy, infrared spectroscopy, spot tests, potentiometry, and neutron activation analysis. Some studies are general. Others were undertaken to analyze pollutants from various media, such as fresh water, salt water, industrial waste streams, and sewage effluents. The pollutants include nutrients, dissolved gases, heavy metals, cyanides, pesticides, and other industrial wastes. (This updated bibliography contains 166 abstracts, 68 of which are new entries to the previous edition.) See also Volume 1, NTIS/PS-76/0037, covering 1970 through June 1974.

42008 (NTIS/PS—77/0046) **Biodeterioration of oil spills (a bibliography with abstracts). Report for 1964—Jan 1977.** Harrison, E.A. (National Technical Information Service, Springfield, Va. (USA)). Feb 1977. 110p. NTIS, PC N01/MF A01.

Supersedes NTIS/PS—76/0032 and NTIS/PS—75/152.

The selected abstracts report on algae, bacteria, hydrocarbons, petroleum degradation, oil spills, beach cleanups and microbial degradation as related to biodeterioration of oil spills. (This updated bibliography contains 105 abstracts, 6 of which are new entries to the previous edition.)

42009 (PB—255 293) **Impact of non-point pollution control on western Lake Superior. Red clay project-work plan. Work plan report May 74—Dec 78.** Andrews, S.C.; Christensen, R.G.; Wilson, C.D.; Houtman, D.S. (Douglas County Soil and Water Conservation District, Superior, Wis. (USA)). Feb 1976. 188p. NTIS $7.50.

The goal of the Red Clay Area project is to initiate and implement an action program for soil erosion and sediment control in the Lake Superior Basin which will lead into a basin-wide program. Institutional arrangements and vehicles for intergovernmental cooperation between local governmental implementing authorities on an interstate basis will be established to solve the basin-wide red clay erosion and sediment problems. Various types of structural and non-structural treatment measures to control major sediment sources will be evaluated to determine quantity of sediment reduced per unit cost of treatment and the impact on water quality. New and innovative techniques for controlling or preventing sedimentation will be demonstrated. (GRA)

42010 (PB—256068) **Monitoring groundwater quality: monitoring methodology. Final report.** Todd, D.K.; Tinlin, R.M.; Schmidt, K.D.; Everett, L.G. (General Electric Co., Santa Barbara, Calif. (USA). Center for Advanced Studies). Jun 1976. Contract EPA-68-01-0759. 169p. (GE—75TMP-68). NTIS $6.75.

See also PB—255492.

The first section of this report describes the needs, objectives, and constraints of monitoring groundwater quality with particular emphasis on the problem as viewed by the United States Environmental Protection Agency, given its legislative mandates in the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500), and the Safe Drinking Water Act of 1974. The second section develops a methodology for monitoring groundwater quality degradation resulting from man's activities. The methodology is presented in the form of a series of procedural steps arranged in chronological order. By so doing, a straightforward sequence of actions is outlined which can lead to a groundwater pollution monitoring program in a given area. The third and final section of the report provides information on groundwater quality. A description is given of the geologic framework governing the movement of groundwater, and natural underground water quality. The occurrence of groundwater pollution, including its distribution, mechanisms, attenuation, evaluation, and trends is presented. The constituents in polluted groundwater and the various sources and causes of pollution are reviewed. (GRA)

42011 (PB—258263) **Inactive and abandoned underground mines. Water pollution prevention and control.** Scott, R.L.; Hays, R.M. (Baker (Michael), Jr., Inc., Beaver, Pa. (USA)). Jun 1975. Contract EPA-68-01-2907. 322p. NTIS $9.75.

Underground mining operations across the United States produce a number of environmental problems. The foremost of these environmental concerns is acid discharges from inactive and abandoned underground mines that deteriorate streams, lakes and impoundments. Waters affected by mine drainage are altered both chemically and physically. This report discusses in Part I the chemistry and geographic extent of mine drainage pollution in the United States from inactive and abandoned underground mines; underground mining methods; and the classification of mine drainage control techniques. Control technology was developed mainly in the coal fields of the Eastern United States and may not be always applicable to other regions and other mineral mining. Available at-source mine drainage pollution prevention and control techniques are described and evaluated in Part II of the report and consist of five major categories: (1)Water Infiltration Control; (2)Mine Sealing; (3)Mining Techniques; (4)Water Handling; and (5)Discharge Quality Control. This existing technology is related to appropriate cost data and practical implementation by means of examples. (GRA)

42012 (PB—258271) **Treatment effectiveness for the removal of selected contaminants from drinking water. Final report.** Stone, R.; Smallwood, H.A.; Marsh, J.R. (Stone (Ralph) and Co., Inc., Los Angeles, Calif. (USA)). Jul 1975. Contract EPA-68-01-2692. 199p. NTIS $7.50.

An extensive literature survey was conducted to determine treatment methods for removing antimony, beryllium, cobalt, lithium, molybdenum, nickel, tungsten, vanadium, bisethers, polychlorinated biphenyls, chlorinated hydrocarbon insecticides, and organophosphorus insecticides from drinking water. The processes discussed included ion exchange, reverse osmosis, electrodialysis, distillation, coagulation/precipitation, chemical oxidation, radio-chemical degradation, and adsorption. Treatment efficiencies were determined in terms of influent and effluent concentrations for each applicable treatment method. Process designs, constraints and limitations, operating conditions, and costs were presented for each treatment process discussed. Each process was evaluated as to its availability, applicability, and technical and economic feasibility. The best available and best technically feasible treatment processes were presented for each contaminant. (GRA)

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 41140, 41961, 42117

42013 (LA—6638-M) **Effluent and sanitary sewer monitors.** Stanchi, L.; Vasey, M.R. (Los Alamos Scientific Lab., N.Mex. (USA)). Mar 1977. Contract W-7405-ENG-36. 25p. Dep. NTIS, PC A03/MF A01.

Two similar instruments that monitor the liquid wastes from the plutonium facility are described. The operation of the two instruments is completely automatic and performs a continuous surveillance in the frame of Nuclear Safeguards. One instrument controls the liquids from the facility and the other checks the sanitary sewer wastes. Both have self-diagnosing capabilities and take automatic actions in case of abnormal occurrences.

THERMAL EFFLUENTS MONITORING AND TRANSPORT

42014 (ANL—75-60(Pt.4), pp 58-63) **Eddy-flux measurements at the Dresden cooling pond.** Hicks, B.B.; Wesely, M.L.; Sheih, C.M. 1975.

In Radiological and Environmental Research Division annual report. Part IV. Atmospheric physics.

Investigations of the fluxes of heat and momentum above the Dresden nuclear power plant cooling pond made using fast-response sensors employing hot wire aneometers were used to derive improved bulk aerodynamic formulae, similar to the relationships commonly used in engineering studies of cooling pond design and performance. The flux parameterization formulations that resulted from the field studies are based upon micrometeorological flux-gradient relationships that properly account for the effects of such fundamental factors as the wind-driven surface drift, the velocity-dependent roughness of the water surface, and the instability of the lower atmosphere. The last quantity is of considerable importance in the case of industrial cooling ponds, since the surface temperature is sometimes much greater than that of the air, and accordingly, the atmosphere is very unstably stratified. In recognition of the seasonal variation of cooling pond thermal performance, efforts were made to investigate the heat transfer properties of the Dresden pond complex over a large range of surface temperatures from about 15 C to as high as 42 C. The analysis performed using the flux data resulted in a set of equations suitable for evaluating the heat flux from a cooling pond by use of bulk data obtained in a relatively simple manner. The 1975 series of measurements verified 1974 findings and also showed that the relationships developed do indeed apply in the case of the latent heat flux.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 40857, 40858, 40859, 40860, 40990

REGULATIONS

REFER ALSO TO CITATION(S) 40991, 41597, 41649, 41652

42015 (PB—254834) **Sensors for continuous monitoring of toxic ions, nutrients, and dissolved gases in water.** Shuman, M.S.; Fogleman, W.W. (North Carolina Water Resources Research Inst., Raleigh (USA)). Apr 1976. Contract DI-14-31-0001-4157. 137p. (UNC-WRRI—76-113). NTIS $6.00.

Ion-selective electrodes and a new type of dissolved gas sensor based on piezoelectric crystals were assessed for use in continuous monitoring of water quality. Relevant stream and effluent water quality standards were reviewed in order to define the constraints on the use of these sensors. The use of sensors in continuous monitoring programs in the United States and other countries was also examined and reviewed. The state-of-the-art of ion-selective electrodes for toxic ions, nutrients and dissolved gases in water was reviewed. A tabular summary of electrode characteristics and an extensive bibliography were compiled. Recommendations for the use of these sensors were made with consideration of the practical problems encountered in continuous monitoring. A dissolved gas sensor for carbon dioxide utilizing a coated piezoelectric crystal was fabricated and evaluated. Didodecylamine and dioctadecylamine were useful coating materials but were also sensitive to water vapor and sulfur dioxide. A probe was designed with the crystal isolated from the aqueous sample by a film of polyvinyl chloride, cast Teflon or by a microporous Teflon filter.

ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

SOCIAL AND ECONOMIC STUDIES

REFER ALSO TO CITATION(S) 41585, 41599, 41604, 41611

42016 **Assessment of long-term environmental impacts by computer modeling.** Guter, G.A.; Ryan, T.C.; Westermeier, J.F. (Boyle Engineering Corp., Newport Beach, CA). pp 949-953 of In Proceedings of the 1976 summer computer simulation conference. La Jolla, CA; Simulation Councils, Inc. (1976).

From Summer computer simulation conference; Washington, District of Columbia, United States of America (USA) (12 Jul 1976).

See CONF-760703—.

Applications of the KSIM technique were made in the course of environmental studies for water and wastewater projects. The National Environmental Policy Act mandates a systematic interdisciplinary approach which will insure the integrated use of natural and social sciences and the environmental design arts in planning and in decision-making which will have an impact on man's environment. KSIM is being employed as a part of this interdisciplinary approach. This application of KSIM requires modification of published techniques for water resource planning and adaptation to the cases discussed. The computer simulation as applied to proposed water and wastewater projects and a recreational lease to an Indian tribe are discussed herein. In the latter case, refinements in the method were employed to simplify the cross-impact analysis and achieve a broader panel participation through the use of questionnaires.

ASSESSMENT OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 40990, 41599

42017 **Computer simulation of environmental impact.** Smith, E.T. pp 939-942 of In Proceedings of the 1976 summer computer simulation conference. La Jolla, CA; Simulation Councils, Inc. (1976).

From Summer computer simulation conference; Washington, District of Columbia, United States of America (USA) (12 Jul 1976).

See CONF-760703—.

The use of computers to analyze environmental impact has evolved markedly over the last five years. A principal motivation for this process has been the National Environmental Policy Act (NEPA), passed in 1969. This Federal law, and similar State statutes and regulations, required the preparation of environmental impact statements for activities involving Federal funds which significantly affect the environment in some manner. The fact that interpretation is possible concerning not only what constitutes a significant impact, but how an impact should be defined at all, has fostered an open-ended situation leading to the development of many techniques relying on the computer, and with great diversity in terms of level of aggregation, the types of data elements included, space and time scales, and most importantly, the kinds of decisions that are possible using the various methods. However, central thesis is that a host of computer simulation techniques exist that make possible some kind of partial estimate of environmental impact, and that while some of these have resulted from NEPA, some of the most sophisticated have not, and thus contain great potential for enhancing the impact assessment process. It is a key fact that the flexibility built into NEPA makes the use of this wide variety of tools possible.

ENVIRONMENTAL IMPACT STATEMENTS

REFER ALSO TO CITATION(S) 42138

BIOMEDICAL SCIENCES, BASIC STUDIES

BIOCHEMISTRY

REFER ALSO TO CITATION(S) 41198, 42044, 42045, 42047, 42048, 42063, 42064, 42083

42018 (BNL—50453, pp III.3-III.36) **Neutron diffraction analysis of the structure of retinal photoreceptor membranes and rhodopsin** Yeager, M.J. (Yale Univ., New Haven). 1976.

From Symposium on neutron scattering for the analysis of biological structures; Upton, New York, USA (2 Jun 1975).

In Neutron scattering for the analysis of biological structures.

Neutron scattering is used to investigate two structural problems of the visual system. Results suggest that the lipid layer is a major structural motif of the extradisc region of intact retinas, and that nonaqueous material such as soluble protein or carbohydrate may also reside there. Solution scattering experiments with neutron radiation indicate that rhodopsin has a very asymmetric shape and is an amphipathic molecule with hydrophobic and hydrophilic surfaces, restricting transmembrane motion and ruling out its function as a diffusional carrier of ions.

42019 (BNL—50453, pp III.37-III.57) **Neutron diffraction studies of biological membranes and membrane components.** Worcester, D.L. (Atomic Energy Research Establishment, Harwell, Eng.). 1976.

From Symposium on neutron scattering for the analysis of biological structures; Upton, New York, USA (2 Jun 1975).

In Neutron scattering for the analysis of biological structures.

The paper describes in detail the methods of deuterium exchange and deuterium labeling of biological membranes and membrane components. Also the methods of contrast variation with H_2O—D_2O mixtures, swelling, direct scaling of data from deuterium-labeled structures, and magnetic orientation have provided useful information in neutron diffraction analysis of membrane structures.

42020 (BNL—50453, pp III.58-III.67) **Direct methods for the analysis of lamellar neutron diffraction from oriented multilayers: a difference patterson deconvolution approach.** Blasie, J.K. (Univ. of Pennsylvania, Philadelphia); Schoenborn, B.P.; Zaccai, G. 1976.

From Symposium on neutron scattering for the analysis of biological structures; Upton, New York, USA (2 Jun 1975).

In Neutron scattering for the analysis of biological structures.

A direct method is described for the solution of the phase problem for lamellar neutron diffraction from hydrated oriented multilayers of model membranes. As a result, the neutron-scattering profiles of such model membranes can be uniquely determined. Such methods can easily be extended to cases in which the thickness of the water layer w is somewhat greater than d/2 as long as it is substantially less than d, and to cases in which isotopic labeling is used instead of partial H_2O—D_2O exchange.

42021 (BNL—50453, pp III.68-III.76) **Neutron diffraction studies of nerve myelin.** Kirschner, D.A. (Brandeis Univ., Waltham, MA); Caspar, D.L.D.; Schoenborn, B.P.; Nunes, A.C. 1976.

From Symposium on neutron scattering for the analysis of biological structures; Upton, New York, USA (2 Jun 1975).

In Neutron scattering for the analysis of biological structures.

Neutron diffraction studies on myelin begun 6 years ago to test conclusions about the structure based on correlations of x-ray and chemical data. The work demonstrates the distinctive utility of neutron diffraction in determining the distribution of water and hydrocarbon in membrane structures.

42022 (BNL—50453, pp III.77-III.85) **Neutron diffraction studies of oriented retinal rods.** Chabre, M. (Centre d'Etudes Nucleaires de Grenoble, France); Saibil, H.; Worcester, D.L. 1976.

From Symposium on neutron scattering for the analysis of biological structures; Upton, New York, USA (2 Jun 1975).

In Neutron scattering for the analysis of biological structures.

Results and preliminary analysis of neutron diffraction data obtained on retinal rod outer segments. Neutron diffraction has proven to be an easy and fast technique which complements x-ray diffraction significantly. At this preliminary stage information has already been obtained on the structural changes associated with total bleaching which could not be extracted unambiguously from x-ray data.

42023 (BNL—50453, pp III.86-III.100) **Neutron scattering by collagen.** Miller, A. (Oxford Univ.); Doyle, B.B.; Hulmes, D.J.S.; Jenkins, G.T.; White, J.W. 1976.

From Symposium on neutron scattering for the analysis of biological structures; Upton, New York, USA (2 Jun 1975).

In Neutron scattering for the analysis of biological structures.

An investigation of the specific arrangement of the collagen molecule, using low-angle x-ray diffraction, electron microscopy, electron diffraction, various computer calculations on the known amino acid sequence, and more recently neutron diffraction.

42024 (BNL—50453, pp III.101-III.114) **Neutron diffraction studies of vertebrate striated muscle.** Worcester, D.L. (Atomic Energy Research Establishment, Harwell, Eng.); Gillis, J.M.; O'Brien, E.J.; Ibel, K. 1976.

From Symposium on neutron scattering for the analysis of biological structures; Upton, New York, USA (2 Jun 1975).

In Neutron scattering for the analysis of biological structures.

The paper describes the first measurements of neutron diffraction from vertebrate striated muscle, and discusses the possible structural implications of the results. It is clear that neutron diffraction contributes significantly to the analysis of muscle structure because of the contrast variations in H_2O—D_2O mixtures and the characteristic differences in the scattering densities of different muscle proteins.

42025 (BNL—50453, pp IV.3-IV.19) **Small-angle scattering of proteins in solution.** Stuhrmann, H.B. (Univ., Mainz, Eng.). 1976.

From Symposium on neutron scattering for the analysis of biological structures; Upton, New York, USA (2 Jun 1975).

In Neutron scattering for the analysis of biological structures.

Two extreme states of matter are of special interest in the theory of scattering: the crystalline state and the molecular gas. Compared with paracrystalline structures these two systems give rise to scattering patterns that can be rather easily related to the structure in question.

42026 (BNL—50453, pp IV.20-IV.37) **Protein pair distance determination in the 30 S ribosoma subunit of E. coli.** Engelman, D.M. (Yale Univ., New Haven); Moore, P.B.; Schoenborn, B.P. 1976.

From Symposium on neutron scattering for the analysis of biological structures; Upton, New York, USA (2 Jun 1975).

In Neutron scattering for the analysis of biological structures.

Results of attempts to measure distances between pairs of proteins in the 30S ribosome subunit of E. coli by neutron scattering studies on specifically deuterated particles. Three interprotein distances are reported as are a variety of control experiments done to establish the significance of the results obtained. It is suggested that the interference fringes detected are most appropriately interpreted as indications of the distribution of lengths of interprotein vectors, giving information about protein shape as well as separation. A qualitative example of such an analysis is presented.

42027 (BNL—50453, pp IV.38-IV.48) **Neutron scattering measurements with the label triangulation method on the 50 S subunit of E. coli ribosomes.** Hoppe, W. (Max-Planck-Inst. fuer Biochemie, Munich); May, R.; Stoeckel, P.; Lorenz, S.; Erdmann, V.A.; Wittmann, H.G.; Crespi, H.L.; Katz, J.J.; Ibel, K. 1976.

From Symposium on neutron scattering for the analysis of biological structures; Upton, New York, USA (2 Jun 1975).

In Neutron scattering for the analysis of biological structures.

In the E. coli S ribosomal subunit, proteins L7/L12 and L10 were deuterated by partial reconstitution. The distance between L7/L12 and L10 was measured by the label triangulation method and was found to be approximately 100 A or, with low probability, 60 to 70 A, depending on the concentration.

42028 **Slow phase hemolysis in hypotonic electrolyte solutions.** Chan, T.K.; LaCelle, P.L.; Weed, R.I. (Univ. of Rochester, NY). *J. Cell. Physiol.;* **85**: No. 1, 47-58(Feb 1975).

When a population of erythrocytes is partially hemolyzed the time course of hemolysis can be divided into a fast phase and a slow phase. The slow phase occurs with both rapid and gradual addition of the hypotonic medium (rapid and gradual hemolysis). There is no difference in the osmotic fragility of erythrocytes remaining at 60 minutes after rapid or gradual hemolysis. Erythrocytes near their critical hemolytic volume have an equimolar ouabain-insensitive sodium-potassium exchange. Critical non-hemolytic swelling with resulting stress on the membrane appears requisite to slow phase hemolysis since more non-penetrant sucrose is required to prevent slow phase lysis rather than that which would be predicted from the intracellular colloid osmotic pressure due to hemoglobin. Sucrose protection from slow phase hemolysis thus depends not only on counter-balancing the colloid osmotic pressure, but also removal of sufficient intracellular water to prevent critical membrane strain. This model is consistent with that proposed by Katchalsky. Irreversible membrane changes associated with hypotonic stress manifested by persistent stomatocytic shape change and membrane wrinkling on return of cells to isotonicity appear to be due to critical changes in membrane components. Such cells, having normal indices and specific gravity, are less deformable than control cells in 2.8 μm pore size polycarbonate filters.

42029 **Response of gonadectomized mice to erythropoietic stimulation.** Berkut, M.K.; Walmer, D.K.; O'Shea, M.D. *J. Elisha Mitchell Sci. Soc.;* **91**: No. 2, 51-52(Sum 1975).

Red blood cell production is regulated by humoral factors, in particular erythropoietin, acting on erythroid stem cells in the bone marrow. Higher red blood cell mass in males than in females has been attributed to erythropoietic stimulation by testosterone. The mechanism by which this stimulus occurs is not known. Estrogens generally inhibit erythropoietin production; however, estrogen-sensitized erythroid stem cells in female bone marrow are more sensitive to stimulation than are those in the male. Kinetics of erythropoiesis and responsiveness of castrated male mice to the stimulus of bleeding were investigated using radioiron (Fe 59) as a tracer. Positive erythropoietic response occurred 72 hours after bleeding. Specific activity of hemoglobin was the same in castrated as in normal males previously treated with erythropoietin. Kinetics of hemoglobin syn-

thesis and red blood cell production apparently was not altered by castration. The early production of red cells and hemoglobin leaves doubt that testosterone is the sole regulator. Hemoglobin synthesis in the absence of testosterone suggests that it is not normally required. Possibly, a yet unidentified cholesterol metabolite, having neither estrogenic nor androgenic potencies could be an accessory erthropoietic agent.

42030 Influence of melatonin on erythropoiesis. Walmer, D.K.; Berkut, M.K.; O'Shea, M.D. *J. Elisha Mitchell Sci. Soc.;* **91**: No. 2, 52-53(Sum 1975).

Estrogens are known to inhibit erythropoiesis in mice. Melatonin inhibits growth of ovary and disrupts the estrous cycle. This report is of studies on the action of melatonin in preventing estrogen inhibition of erythropoiesis. Female mice were given melatonin or its precursor, tryptophan, subjected to hypobaria and finally given either saline, erythropoietin or cobalt salt injections. As expected, melatonin adversely affected development of sex organs. Stimulation of erythropoiesis was measured by Fe-59 incorporation into red cells. Erythropoiesis in melatonin-treated mice was increasingly stimulated with increasing doses of cobalt. The animals also showed greater response to erythropoietin treatment than did mice treated with tryptophan. Thus, the antigonadal action of melatonin suppressed inhibitory action of estrogen on erythropoiesis. Without estrogen influence, the mice were more sensitive to stimulatory action of erythropoietin and cobalt.

42031 Melatonin action during hypobaric hypoxia. O'Shea, M.D.; Berkut, M.K.; Walmer, D.K. *J. Elisha Mitchell Sci. Soc.;* **91**: No. 2, 53-54(Sum 1975).

It is believed that the inhibition of gonadal activity by the pineal gland is mediated by melatonin. The influence of melatonin on erythropoietic stimulation in ethypoxic polycythemic male mice may help in elucidation of the role of testosterone in erythropoiesis. Male mice were injected with melatonin or tryptophan and plethora was induced by hypobaric hypoxia. Mice were then injected with either saline, erythropoietin or cobalt chloride. Fe-59 incorporation into hemoglobin and red blood cells was measured. Melatonin-treated animals were slightly less responsive to cobalt, but responded to exogenous erythropoietin as did animals not given melatonin. A direct augmentation of erythropoietin by testosterone probably does not occur. Potentiation by testosterone of the increase in plasma erythropoietin may not be ruled out.

42032 Nucleotide sequence of a viral RNA fragment that binds to eukaryotic ribosomes. Dasgupta, R.; Shih, D.S.; Saris, C.; Kaesberg, P. (Univ. of Wisconsin, Madison). *Nature (London);* **256**: No. 5519, 624-628(21 Aug 1975).

The nucleotide sequence has been determined for the first 53 bases of brome mosaic virus RNA4, the monocistronic messenger for brome mosaic virus coat protein. The sequence includes the binding site for wheat embryo ribosomes. The 5'-terminal base is a modified guanosine attached to the penultimate base through a 5' p-p-p 5' link. The initiating AUG codon is only 10 nucleotides from the 5'-terminus. The 13 triplets following the AUG codon correspond to the known sequence of brome mosaic virus coat protein.

42033 Monosomic analysis of fatty acid composition in embryo lipids of Zea mays L. Plewa, M.J.; Weber, D.F. (Illinois State Univ., Normal). *Genetics;* **81**: 277-286(Oct 1975).

The effects of monosomy of specific chromosomes on the fatty acid composition of maize embryos were studied. A novel technique was developed to obtain fatty acid profiles of single embryos without reducing the viability of the sampled kernels. Monosomic 2 embryos had significantly more oleic acid and significantly less linoleic acid than diploid control embryos. Since the conversion of oleic acid to linoleic acid is a single-enzyme-mediated reaction, we suggest that a gene involved in linoleic acid biosynthesis is located on chromosome 2. Additional consistent variations were found in other monosomic types. This study demonstrates that monosomic analysis can be used to study gene dosage effects at the biochemical level.

42034 Binding and entry of DNA in pneumococcal transformation. Lacks, S. (Brookhaven National Lab., Upton, NY). pp 35-44 of In Modern trends in bacterial transformation and transfection. Portoles, A. (ed.). Amsterdam; Elsevier Scientific Publishing Co. (1976).

DNA transport in pneumococcal transformation can be separated into two steps: binding of DNA to the outside of the cell and entry of DNA into the cell. Both steps involve nuclease action. The binding reaction is specific for nonemcumbered duplex DNA. An RNA:DNA hybrid, glucosylated DNA and denatured DNA are all ineffective competitors for binding. Single-strand breaks are formed in bound DNA, presumably at the sites of binding to the cell surface. Entry of DNA into the cell requires activity of the major endonuclease, which is located in the cell membrane. This enzyme presumably degrades one strand of DNA as the complementary strand segment enters the cell. Magnesium, calcium and potassium ions are all required for DNA entry. A tentative model for DNA binding and entry is presented.

42035 Investigation of the structure of the reaction center in photosynthetic bacteria by optical detection of triplet state magnetic resonance. Clarke, R.H.; Connors, R.E.; Frank, H.A. (Boston Univ.). *Biochem. Biophys. Res. Commun.;* **71**: No. 2, 671-675(1976).

Measurements of the triplet state zero-field splitting and intersystem crossing rate constants for isolated bacteriochlorophyll a and for chemically reduced photosynthetic bacteria are utilized to investigate the geometry of the bacteriochlorophyll dimer in the reaction center.

42036 Structure of plant cell walls. Purification and characterization of a β-1,4-galactanase which degrades a structural component of the primary cell walls of dicots. Labavitch, J.M.; Freeman, L.E.; Albersheim, P. (Univ. of Colorado, Boulder). *J. Biol. Chem.;* **251**: No. 19, 5904-5910(1976).

Wild type Bacillus subtilis, when grown on a soybean arabinan-galactan, secretes a β-1,4-galactanase which has been purified more than 200-fold from the culture fluid. Affinity chromatography was the most effective step in a purification procedure which resulted in a preparation that contained only a single 40,000 molecular weight protein band upon sodium dodecyl sulfate-disc gel electrophoresis. The purified galactanase digests a β-1,4-galactan purified from citrus pectin and digests partially the isolated cell walls of suspension-cultured sycamore cells. The predominant product of the enzymic degradation of the substrates tested is a 4-linked tetragalactose. Evidence is presented to support the hypothesis that the galactanase attacks its substrates in both an exo- and endo-manner. The products obtained upon galactanase digestion of the soybean arabinan-galactan demonstrate that the earlier proposal concerning the structure of this polysaccharide must be incorrect.

42037 Study of Rous sarcoma virus-transformed baby hamster kidney cells using fluorescent probes. Edwards, H.E.; Thomas, J.K.; Burleson, G.R.; Kulpa, C.F. (Univ. of Notre Dame, IN). *Biochim. Biophys. Acta;* **448**: 451-469(1976).

The fluorescent probes pyrene, pyrene butyric acid and N-phenyl 1-naphthylamine have been used to investigate the changes that accompany in vitro transformation of a baby hamster kidney cell line using Rous sarcoma virus. The fluorescent probes which reside in the membrane were used to compare the changes in microviscosity and polarity of the membranes of normal cells with two transformed cell lines. The spectrofluorimetric data indicate that following transformation the probe N-phenyl 1-naphthylamine resides in a more polar environment. However, using the probe pyrene, the yield of excimer indicates decreased mobility of this probe in the membrane of transformed cells. The data also indicate differences between the two transformed cell lines. Laser photolysis was used to study the lifetime of the pyrene probes and the quenching of the pyrene fluorescence in the membrane by several different quenching molecules. The data indicate differences between the three cell lines and suggest that transformation decreases movement within the membrane.

42038 Use of a single venous blood sample to assess oxygen binding to haemoglobin. Lichtman, M.A.; Murphy, M.; Pogal, M. (Univ. of Rochester, NY). *Br. J. Haematol.;* **32**: 89-98(1976).

The measurement of pH, Po_2, PCO_2, and SO_2 in a single venous blood sample can be used to determine the P_{50} at standard or at in vivo conditions. This technique makes it feasible for a physician, firstly, to make an assessment of the net adaptation of the red cell to reductions in blood oxygen content or flow and, secondly, to make an initial assessment of whether a haemoglobin with altered affinity for oxygen is present in subjects with polycythaemia or anaemia.

CYTOLOGY

REFER ALSO TO CITATION(S) 42121

42039 (UCD—472-123, pp 61-65) **Lymphoid colonies.** Shifrine, M.; Wilson, F.D.; Spangler, W.L.; Whaley, C.B.; Dyke, J.A.; Newman, J.; Taylor, N.J. 1976.

In Annual report, fiscal year 1976.

Clumping of lymphocytes can be a problem in quantitation of T-lymphocyte progenitors in methylcellulose culture systems. Clumping can be minimized by shortening the liquid phase preincubation when PHA concentration is increased to get good colony formation. Interpretation of lymphoid colony data from bone marrow culture should be approached with caution in view of the possible formation of granulocyte-monocyte colonies in addition to lymphoid colonies.

42040 Intrinsic material properties of the erythrocyte membrane indicated by mechanical analysis of deformation. Evans, E.A.; La Celle, P.L. (Duke Univ., Durham, NC). *Blood;* **45**: No. 1, 29-43(Jan 1975).

Deformation of the erythrocyte membrane by the micropipette technique permits analysis of intrinsic material characteristics of the membrane and provides a means to differentiate purely membrane factors from such extrinsic factors as surface area-to-volume ratio. Using small micropipettes (less than 0.5 μm radius) to deform cells, it is evident that the red cell membrane behaves like a solid for periods of time up to 5 to 10 min of sustained deformation; for long periods of strain, permanent deformations occur, indicative of the semi-solid structural character. In the time range in which the membrane behaves like a solid, the material is linearly elastic up to strains of 400 percent, implying a loose network structure in the membrane plane, and evaluation of the elastic parameter μ (μ for normal discocytes equals 7 x 10^{-3} dynes/cm) suggests that the elements comprising the network may have a molecular weight of approximately that of the water-soluble membrane protein spectrin. Whether the network system is cross-linked or simply a polymer solution remains unanswered. Experimental data indicate that plastic flow of the membrane under conditions of protracted strain may lead to permanent deformation of the membrane, whereas uniform dilation of the membrane, requiring over 1000 times more energy than for plastic flow, results in membrane failure and lysis. Analyses of the data from larger micropipettes of limiting mean cylindrical diameter show their utility in evaluating extrinsic factors, e.g., surface area-to-volume relationships, which are related to the capability of the whole cell to form a new configuration with implicit resistance to total surface area change, as the cell enters narrow channels of the microcirculation. Thus, micropipettes with diameters in the 2.7 to 3.0-μm range can provide sensitive comparisons of cellular deformability of erythrocytes.

42041 Human cord blood lymphocytes. Ultrastructural and immunologic surface marker characteristics: a comparison with B- and T-cell lymphomas. Hamburg, A.; Brynes, R.K.; Reese, C.; Golomb, H.M. (Univ. of Chicago). *Lab. Invest.;* **34**: No. 2, 207-215(1976).

The ultrastructural and surface marker characteristics of human cord blood lymphocytes were studied. These properties were compared with those in cells of patients in the leukemic phase of both malignant lymphoma, poorly differentiated lymphocytic type, and mycosis fungoides. Nuclear folding in cord blood lymphocytes was similar to that seen in lymphocytes of patients with malignant lymphoma, poorly differentiated lymphocytic type and mycosis fungoides. Surface marker characteristics of cord blood lymphocytes included increased percentages of surface IgD on cells bearing surface immunoglobulins and decreased percentages of E-rosette-forming cells. The hypothesis that both malignant lymphoma, poorly differentiated lymphocytic type and mycosis fungoides represent an arrest in the normal lymphocyte maturation sequence is discussed.

42042 Quantitation of human T-lymphocytes in blood: use of automatic smearing instrument for preparing fixed slides of E-rosettes. Chandra, P.; Borner, G.; Chanana, A.D.; Chikkappa, G.A.; Conkling, K.; Cronkite, E.P.; Sipe, C.R. (Brookhaven National Lab., Upton, NY). *Proc. Soc. Exp. Biol. Med.;* **152**: 330-333(1976).

Human T-lymphocytes were enumerated in 10 normal volunteers and 4 patients by a new method utilizing an automatic smearing instrument to prepare permanent fixed slides of E-rosettes. The results were compared to the commonly employed hemocytometer method. Results obtained by smearing the instrument were similar to those obtained by the hemocytometer method with the added advantages of permanent record, convenience of quantitation, and precise morphological identification of rosette-forming cells. As opposed to well-preserved E-rosettes obtained by the automatic smearing instrument, hand-made smears showed disruption of E-rosettes.

GENETICS

REFER ALSO TO CITATION(S) 42018

42043 (RLO—2221-T2-31) **Increasing the efficiency of azide mutagenesis in barley.** Sander, C.; Nilan, R.A.; Kleinhofs, A.; Vig, B.K. (Washington State Univ., Pullman (USA). Dept. of Agronomy and Soils). 1976. Contract EY-76-C-06-2221. 17p. Dep. NTIS, PC A02/MF A01.

In both the higher plant and bacterial systems, ozide appears to be a highly efficient mutagen with some apparently rather unique properties. However, its mechanism in vivo is not yet clear. Results are reported from studies on the effects of azide administered at fixed intervals to barley seedlings. Effects on DNA synthesis and chromosomes were studied. The effects of azide on chromosomes in cultured human lymphocytes were also studied.

42044 Synteny between the Pro^+ marker and human glutamate oxaloacetate transaminase. Jones, C. (Roosevelt Inst. for Cancer Research, Denver). *Somatic Cell Genet.;* **1**: No. 4, 345-354(1975).

Chinese hamster ovary cells with a specific auxotrophy for proline were fused with human cells from a variety of sources and the resulting hybrids analyzed for human genetic markers. Of 63 hybrid clones examined, 27 possessed both proline and cytoplasmic glutamate oxaloacetate transaminase markers; 36 had neither; and no clones were found possessing one and not the other. These results constitute evidence that the proline and glutamate oxaloacetate transaminase markers are syntenic. Evidence for absence of synteny between these and a variety of other human genes is presented. Biochemical tracer experiments established that the proline biosynthetic pathway through glutamate has been restored in the Pro^+ hybrids.

42045 Studies of temperature sensitive mutants of bacteriophage Qβ, defective in both replication and translation. Gupta, P.; Radloff, R.J.; Kaesberg, P. (Univ. of Wisconsin, Madison). *J. Gen. Virol.;* **28**: 329-340(1975).

Temperature sensitive mutants of bacteriophage Qβ have been isolated which fail in the synthesis of their virus RNA at the non-permissive temperature (42°C). Nine mutants have been studied in some detail. Cells infected with these mutants at 37°C and incubated long enough to produce substantial amounts of Qβ RNA cease Qβ RNA replication when shifted to 42°C. The mutants can be classified into 3 groups according to the amount of Qβ RNA replicase activity exhibited in extracts from infected cells isolated at various times after shift to 42°C: in group I mutants, enzyme activity is the same, regardless of the time of isolation after shift; in group 2 mutants enzyme activity increases with time of isolation after shift; in group 3 mutants, enzyme activity decreases with time of isolation after shift. Synthesis of all virus proteins is suppressed at 42°C in cells infected with group I or group 3 mutants. In cells infected with group 2 mutants, synthesis of Qβ RNA replicase subunit β is increased, but synthesis of other virus proteins is depressed at 42°C. The inhibition of virus RNA and protein synthesis is reversible. A detailed analysis of these experiments suggests that a defective Qβ RNA replicase is involved in the inhibition of both virus RNA and protein synthesis.

42046 Gene control mechanisms and their possible bearing on the neutralist-selectionist controversy. Wallace, B. (Cornell Univ., Ithaca, NY). *Evolution;* **29**: No. 2, 193-202(30 Jun 1975).

This paper deals with mechanisms of gene control in higher organisms; specifically, it considers in some detail two aspects of a model proposed by Wallace and Kass (1974) in which a selective advantage is said to reside in the possession of dissimilar sequences of transcription-initiating sensors at homologous gene loci. The advantage that may arise by virtue of dissimilar allelic sequences is examined in detail by means of a simple example. Second, the bearing of the model on the current neutralist-selectionist controversy is discussed. Under the proposed model, the advantage of heterozygotes appears to be inversely correlated with population size, growing as population size decreases.

42047 Mutants of the Chinese hamster ovary cell line requiring analine and glutamate. Hankinson, O. (Roosevelt Inst. for Cancer Research, Denver). *Somatic Cell Genet.;* **2**: No. 6, 497-507(1976).

One alanine-requiring mutant and four glutamate-requiring mutants of probable independent origin were isolated from the CHO-Kl line. Both types of mutants require unusually high concentrations of the appropriate amino acid for growth. The alanine-requiring mutant is deficient in alanyl-tRNA synthetase activity. The one glutamate-requiring mutant that was studied possesses full activity of glutamyl-tRNA synthetase and its biochemical defect has not been identified.

42048 Single-strand breakage on binding of DNA to cells in the genetic transformation of Diplococcus pneumoniae. Lacks, S.; Greenberg, B. (Brookhaven National Lab., Upton, NY). *J. Mol. Biol.;* **101**: 255-275(1976).

Mutants of Diplococcus pneumoniae that lack a membrane-localized DNAase are defective in transformation because entry of DNA into the cell is blocked. Such mutants still bind DNA on the outside of the cell. The bound DNA is double-stranded and its double-stranded molecular weight is unchanged. Its sedimentation behavior in alkali, however, shows that it has undergone single-strand breakage. The breaks are located randomly in both strands of the bound DNA at a mean separation of 2 x 10^6 daltons of single-stranded DNA. Both binding and single-strand breakage occur in the presence of EDTA. Single-strand breaks are similarly formed on binding of DNA to normally transformable cells in the presence of EDTA. The single-strand breaks appear to be a consequence of attachment. DNA may be bound to the cell surface at the point of breakage. A mutant that is partially blocked in entry also binds DNA mainly on the outside of the cell. In the presence of EDTA, DNA bound by this mutant undergoes only single-strand breaks. In the absence of EDTA, however, double-strand breaks occur, apparently as a result of the initiation of entry. It is possible that the double-strand breaks arise from additional single-strand breaks opposite those that occurred on binding. The double-strand breaks presumably result from action of the membrane DNAase as it begins to release oligonucleotides from one strand segment while drawing the complementary strand segment into the cell.

42049 Evolution of 5S ribosomal RNA genes in the chromosomes of the virilis group of Drosophila. Cohen, M. Jr. (Oak Ridge National Lab., TN). *Chromosoma;* **55**: 359-371(1976).

Drosophila melanogaster 5S ribosomal RNA labeled with ^{125}I was used as an in situ hybridization probe to localize complementary sequences in chromosomes of species in the Drosophila virilis group. Whereas virilis, the ancestral species, has two different 5S gene loci, the derived species show only one of these loci; in the two lines that have evolved from virilis, it is the opposite locus that is conserved. The possible events leading to such an arrangement are discussed.

42050 Reversions of two proline-requiring auxotrophs of Haemophilus influenzae by N-methyl-N'-nitro-N-nitrosoguanidine and hydrazine. Kimball, R.F. (Oak Ridge National Lab., TN). *Mutat. Res.;* **36**: 29-38(1976).

New mutation detection systems are described for Haemophilus influenzae. They involve two independently isolated proline auxotrophs which appear to be mutants at different sites in a proline locus (proB) that is very closely linked to a locus (thd) for thymidine requirement. One of the mutants, proB1, appears to revert to prototrophy only by mutations at the locus. The other, proB2, reverts both by mutation at the locus and by unlinked suppressors. The latter account for about 90 percent of the reversions induced by MNNG and by HZ. The close linkage of proB to thd was used to distinguish between true revertants and suppressors by a transformation test. A comparison was made between the mutation induction kinetics of the different classes of revertants and mutations to novobiocin resistance with MNNG and HZ. The very different induction kinetics for these two mutagens previously reported for the novobiocin resistance system were also found for the proline systems. There were some differences between the detection systems, however, in the frequency of induced mutation relative to the spontaneous frequency and, in one case, in the form of the induction curve. It is concluded that the major features of the induction curves reflect the amount of damage done to DNA and so are general for all systems, but that there are some features which are locus- or site-specific.

METABOLISM

42051 Sufficient absorption: a quantitative method to replace exhaustive absorption. Reif, A.E.; Robinson, C.M. (Mallory Inst. of Pathology, Boston). *J. Immunol. Methods;* **8**: 109-116(1975).

At present, the only guideline for removal of undesired reactivities from an antiserum is that no activity against the cross-reacting (undesired) antigens should remain after exhaustive absorption. Since this guideline sets no upper limit on the amount of undesired antigens required for an exhaustive absorption, waste of possibly precious material and of time in performing multiple sequential absorptions can result. To minimize the quantity of antigen and of experimental work required for an absorption, a quantitative approach is suggested: the antiserum is test-absorbed with various amounts of the undesired antigens, and antibody activity still present against these antigens is then tested. The results can be plotted as a curve by use of Reif's modification of the Von Krogh equation. Thus, the exact amount of undesired antigens sufficient to remove all detectable reactivity against these antigens can be determined. The procedure is termed 'sufficient' rather than 'exhaustive' absorption, to stress that only detectable amounts (rather than every last trace) of undesirable antibodies have been removed. The nomenclature 'exhaustive absorption' gives no indication that any practical attempt to achieve it can hardly escape having the same limitations as 'sufficient absorption'; it is therefore suggested that the misleading non-quantitative nomenclature 'exhaustive absorption' be eliminated from immunological terminology. 'Sufficient absorption' has been applied to the absorption of undesired (blood group) antibodies from rabbit antisera to CEA.

42052 Selective suppression of immune responses. Regulation of antibody formation and cell-mediated immunity by antibody. Fitch, F.W. (Univ. of Chicago). *Prog. Allergy;* **19**: 195-244(1975).

Cellular events in the immune response are reviewed with regard to antibody formation, cell-mediated immunity, and activation of lymphoid cells by antigen. Studies on the regulation of immune response by antibody are reviewed with regard to afferent, efferent, and central mechanisms; effect of antibody on primary and secondary antibody responses and on immunological memory; regulation of cell-mediated immune responses; regulation by different immunoglobulin classes; and feedback regulation of antibody formation. Studies on regulation of immune response by anti-receptor antibody are also reviewed. (HLW)

42053 Improved methods for reducing calcium and magnesium concentrations in tissue culture medium: application to studies of lymphoblast proliferation in vitro. Brennan, J.K.; Mansky, J.; Roberts, G.; Lichtman, M.A. (Univ. of Rochester, NY). *In Vitro;* **11**: No. 6, 354-360(1975).

We have compared several methods for reducing calcium and magnesium concentrations in tissue culture medium, with the objective of producing selective deficiency effects on the growth of mouse (L5178Y) and human (P1R) lymphoblasts. In experiments in which calcium- and magnesium-"free" McCoy's medium was supplemented with 15 percent horse or fetal calf serum, enough calcium and magnesium were provided by serum to support normal lymphoblast growth rate. Either dialysis or chelating-resin treatment of horse or fetal calf serum reduced calcium and magnesium contents approximately 100-fold. Use of dialyzed sera resulted in reduced growth rate, although in most cases the reduction in growth could be attributed to other effects of dialysis on serum, inasmuch as growth in those experiments was not restored to normal by the addition of calcium and magnesium to the medium. In contrast, the reduction of lymphoblast growth rate that occurred when resin-treated serum was used was always attributable to removal of calcium and magnesium, as normal growth always occurred in cultures to which calcium and magnesium were added.

42054 Metabolism of labeled parathyroid hormone. VII. Attempts to modify hormone deposition. Neuman, M.W.; Neuman, W.F.; Lane, K. (Univ. of Rochester, NY). *Calcif. Tissue Res.;* **19**: 169-178(1975).

Using a ^{125}I-labeled parathyroid hormone with apparently full biological activity, a series of experiments was performed on rats to determine the effects of several physiological parameters on the deposition and metabolism of the hormone in the target tissues, liver, kidney and bone. Among the variables studied were: systemic phosphate levels, systemic calcium levels, calcitonin administration, pregnancy, and dosage (at low levels). Some small variations in deposition and tissue metabolism of the hormone were observed but the invariance of the pattern of deposition and the rapid automatic destruction by target tissues were most impressive.

42055 Bacillus subtilis deoxyuridinetriphosphatase and its bacteriophage PBS2-induced inhibitor. Price, A.R.; Frato, J. (Univ. of Michigan, Ann Arbor). *J. Biol. Chem.;* **250**: No. 22, 8804-8811(1975).

Extracts of Bacillus subtilis contain a deoxyuridinetriphosphatase (dUTPase) activity with a molecular weight of approximately 48,000. The enzyme is maximally active at pH 8.5, being stimulated by Mg^{2+} and inhibited by EDTA. The enzyme is specific for dUTP among all the natural nucleotides tested, with an apparent K/sub m/ for dUTP of 2 μM. Bacteriophage PBS2, whose DNA contains uracil instead of thymine, induces upon infection of B. subtilis a new 83,000-dalton protein which inhibits the host's dUTPase. The inhibitor acts immediately and reversibly in vitro to inhibit dUMP production from dUTP. The inhibitor's action is maximal in dUTPase assays performed at pH 6 to 7, and is minimal at pH 9.7. The inhibitor seems to form a higher molecular weight complex with the B. subtilis dUTPase. Increasing the pH of the medium for PBS2 infection from pH 7 to pH 8.85 caused a dramatic decrease in the synthesis of phage DNA and progeny phage. The newly synthesized DNA had an altered thymine/uracil ratio, being increased from less than 0.03 to greater than 1.0. We propose that infection at high pH prevents the PBS2-induced dUTPase inhibitor from blocking the B. subtilis dUTPase activity, thereby allowing the degradation of dUTP and the synthesis of dTTP (both of which are DNA polymerase substrates), so that thymine replaces some of the uracil normally found in PBS2 DNA.

42056 Immunogenic and antigenic properties of a rat Moloney sarcoma. Jones, J.M.; Feldman, J.D. (Scripps Clinic and Research Foundation, La Jolla, CA). *Behring Inst. Mitt.;* No. 56, 14-18(Mar 1975).

In order to evaluate the role of antigen in tumor progression and the nature of its reactions with agents that influence tumor growth, the extraction and characterization of surface antigens expressed by the Moloney sarcoma was undertaken. Antibodies were labeled with ^{125}I and were adsorbed to and eluted from the surface of tumor cells. Tables are presented to show binding of ^{125}I-labeled anti-tumor antibody to sarcoma cells; coprecipitation of viral, tumor, and alloantigens extracted with potassium iodide; and inhibition of specific coprecipitation with unlabeled antigen. (HLW)

42057 Age and seasonal differences in the synthesis and metabolism of testosterone by testicular tissue and pineal HIOMT activity of Uinta ground squirrels (Spermophilus armatus). Ellis, L.C.; Balph, D.F. (Utah State Univ., Logan). *Gen. Comp. Endocrinol.;* **28**: 42-51(1976).

Male Uinta ground squirrels (Spermophilus armatus) were sacrificed from a free-living population during the breeding season, which immediately followed emergence from hibernation; after the reproductive season; and just prior to aestivation/hibernation. HIOMT activity of the pineal gland was assayed and related to the ability of the gonads to synthesize and metabolize testosterone. Older squirrels had higher HIOMT activity than did the younger animals. The activity of this enzyme was lowest in squirrels during the breeding season. HIOMT activity increased after the breeding season to its highest level just before the squirrels enter aestivation/hibernation. At this time, testicular weight increased concomitant with an apparent increase in HIOMT activity. Testicular size and

weight were largest at the time of emergence of the animals from hibernation. Androgen synthesis was also greatest during the breeding season. As would be expected, both decreased rapidly thereafter. The testes formed little 17α,20α-dihydroxyprogesterone during or after the breeding season, contrary to what has been reported for rats and house sparrows. The older squirrels demonstrated a greater capacity for testosterone metabolism during the breeding season than did the younger animals.

42058 Methylmercury movements across the perfused guinea pig placenta in late gestation. Kelman, B.J.; Sasser, L.B. (Comparative Animal Research Lab., Oak Ridge, TN). *Toxicol. Appl. Pharmacol.;* **39**: 119-127(1977).

Placentas from guinea pigs between 61 and 63 days gestation were perfused from the fetal side in situ at rates ranging from 0.35 to 4.54 ml/min. The dam was injected intravenously with tracer quantities of tritiated water and radiolabeled mercury in the form of methylmercuric chloride. Maternal plasma and the perfusate samples were analyzed for radiolabeled mercury and tritiated water, and corrections were made for net water flows by using radioiodinated serum albumin. Radiomercury and tritium clearances were therefore measured concurrently. The clearance of tritiated water was a linear function of perfusion rate. The relationship between tritium clearance and perfusion rate for all experiments combined was described by the equation: y = 0.16 + 0.54x, where y is tritium clearance and x is perfusion rate. Clearance of radiolabeled mercury measured 0.15 +- 0.01 ml/min (mean +- SE). No significant relationship between radiomercury and tritium clearance was detected. It appears that calcium and low concentrations of methylmercury may move across the placenta by the same or similar mechanisms.

MEDICINE

TRACER TECHNIQUES

42059 (AD-A—031114) **Robust calibration. Technical report.** Tiede, J.J.; Pagano, M. (State Univ. of New York, Buffalo (USA). Statistical Lab.). May 1976. Contract N00014-72-C-0508. 11p. NTIS, PC A02/MF A01.

Presented at Computer Science and Statistics Annual Symposium on the Interface (9th), Apr 76, Cambridge, Mass.

A method is presented for fitting radioimmunoassay calibration curves which are used for measuring the concentration of various antigens in vitro. The curves to be fitted are modified hyperbolae on the basis of only a few observations (typically 12 to 16). Previous methods of fitting involved either linearizing the curve and estimating by least squares or fitting directly by nonlinear least squares. Unfortunately, the linearization techniques used are not usually successful in their intent and, furthermore, outliers are quite common due to the large number of sources of error. The algorithm devised and used successfully for finding M-estimates of the radioimmunoassay curves is presented, and its superiority to the method of least squares in the presence of outliers and also its similarity to least squares in the absence of outliers is demonstrated. (GRA)

42060 (PB—262160) **Quantitation of ischemic and infarcted myocardium: relation between 99 Tc pyrophosphate and regional and total coronary blood flow, myocardial function and metabolism. Annual scientific report, 1 Jul 1975—31 Mar 1976.** Parmley, W.W.; Botvinick, E.H. (California Univ., San Francisco (USA)). 15 Apr 1976. Contract N01-HV-5-2989. 85p. NTIS, PC A05/MF A01.

The contract was designed to evaluate the use of selected radionuclide techniques in evaluating the size of acute myocardial infarction in patients. Supplementary studies have suggested that there is a reasonable quantitative relationship in dogs with experimental myocardial infarction. During this first year several studies were done to evaluate the sensitivity and specificity of these radionuclide techniques. In a prospective study of perioperative infarction following saphenous vein bypass grafting, new Q waves on the electrocardiogram and a positive discrete technetium pyrophosphate image had approximately the same sensitivity and specificity for perioperative infarction. Perfusion imaging with rubidium 81 and thallium 201 proved to be quite sensitive and specific for previous myocardial infarction. In 23 patients with acute myocardial infarction there was a general relationship between the size of the pyrophosphate image and hemodynamic parameters.

42061 Scintiphotos in the diagnosis of renal allograft malfunction. Payne, J.; Telfer, N.; Barbour, B.H.; Berne, T.V. (Univ. of Southern California, Los Angeles). *Proc. Clin. Dial. Transplant Forum;* **2**: 17-21(1972).

Scintigraphy and other radioisotope techniques using hippuran have become a useful adjunct in the monitoring of renal allograft function. Technetium has been used in the evaluation of renal blood flow, rejection, and post-transplant anuria. Combined assessment provides a good compromise and enables various complications following transplantation to be differentiated. This review was undertaken in order to correlate the visual interpretation of 158 scintiphoto studies with the clinical course of 89 renal allografts. The accuracy and reproducibility of the techniques have been evaluated to determine practical indications for the use of gamma camera studies in the diagnosis of renal allograft malfunction.

MICROBIOLOGY

REFER ALSO TO CITATION(S) 41109, 41169

PHYSIOLOGICAL SYSTEMS

REFER ALSO TO CITATION(S) 42029, 42030, 42031, 42118

42062 (CALT—767P6-X11) **Studies in developmental immunogenetics. Annual progress report.** Owen, R.D. (California Inst. of Tech., Pasadena (USA). Div. of Biology). 26 May 1976. Contract EY-76-S-03-0767-006. 9p. Dep. NTIS, PC A02/MF A01.

Progress is reported on studies of genetic regulation, mainly in complex organisms, and with an emphasis on the immune system as a model for developmental analysis and as a tool for following the development of other systems, especially the brain. Results are reported from studies of biochemical genetics, primarily from a developmental viewpoint and with particular regard to defense mechanisms; cellular aspects of the immune system; the area of cancer immunology and cell specificities as related to tumor systems, primarily from an immunogenetic viewpoint and with particular reference to leukemias in the mouse; and the disruptions of genetic control mechanisms in tumor development, especially as approached through the reappearance of fetal antigens associated with tumor development.

42063 (UCD—472-123, pp 45-49) **Morphologic and hormonal aspects of the estrous cycle in the dog: a review.** Andersen, A.C.; Joechle, W. 1976.

In Annual report, fiscal year 1976.

Current morphologic and hormonal information on the estrous cycle of the dog briefly are reviewed. Reports on hormonal profiles in this species largely have dealt only with the breeding period. Although morphologic changes during the extended periods of metestrus and anestrus have been described, corresponding hormonal changes during the processes of endometrial desquamation and repair remain obscure.

42064 (UCD—472-123, pp 53-56) **Preliminary investigation of plasma sex hormone concentrations in normal and clinically abnormal male beagles.** Parks, N.J.; Tsuboi, K.K.; Muggli, F.M. 1976.

In Annual report, fiscal year 1976.

A limited pilot study demonstrated detectable trends in plasma sex hormones in normal and clinically abnormal beagles. Elevated testosterone (T) and dihydroxytestosterone (DHT) values were found concurrent with unilateral interstitial cell testicular tumors. A ratio of T/DHT, providing a measure of androgenic hormone imbalances, showed values somewhat higher than controls for cases of benign prostatic hyperplasia and testicular tumors.

42065 (UCD—472-123, pp 87-88) **Leukocyte migration inhibition assay.** Thilsted, J.P.; Shifrine, M. 1976.

In Annual report, fiscal year 1976.

Cell mediated immunity in dogs was determined using an assay that measures leukocyte migration inhibition by supernates from antigen-stimulated lymphocytes. PPD-stimulated cultures inhibited leukocyte migration more than 20 percent, whereas unstimulated cultures had little effect on leukocyte migration.

42066 (UCD—472-123, pp 114-115) **Age-related changes in thyroid function in beagle pups.** Book, S.A.; McNeill, D.A.; Berding, K.L. 1976.

In Annual report, fiscal year 1976.

Serum thyroxine (T_4) and the binding capacity of thyroxine-binding proteins, as indicated by ^{125}I-triiodothyronine resin sponge uptake (T_3-RSU), were determined in young beagles every 10 days between 3 and 103 days of age. Highest T_4 concentration and lowest T_3-RSU were observed in dogs 13 to 33 days of age. The divergence of these values suggests that much of the increased T_4 concentration in pups in early life results from increased thyroxine-binding capacity of serum proteins.

42067 Contractility of rat testicular seminiferous tubules in vitro: prostaglandin F/sub 1α/ and indomethacin. Buhrley, L.E.; Ellis, L.C. (Utah State Univ., Logan). *Prostaglandins;* **10**: No. 1, 151-162(Jul 1975).

The frequency of spontaneous in vitro contractions of seminiferous tubules of the rat appeared to be increased in a dose-dependent manner by prostaglandin F/sub 1 alpha/. PGF/sub 1 alpha/ treatment increased the tonus of the smooth muscle cells in the wall

of the tubules as indicated by a reduction in the diameter of the tubules. When the tubules were rinsed successively with fresh Tyrode's solution, the contractile frequency was diminished. Returning the original bathing medium to the tubules restored their contractile frequency, as did treatment of the rinsed tubules with PGF/sub 1 alpha/ (10^{-7}M). Preinjecting the rats with indomethacin tended to reduce the contractile frequency of the extirpated tubules. Treating the tubules with a solution of indomethacin for 90 min., in vitro was more effective than pretreatment in vivo in reducing contractile frequency, but a combination of these two procedures produced the greatest inhibition. PGF/sub 1 alpha/ restored the contractile frequency of the indomethacin-treated tubules. Our results indicate that PGs modulate the in vitro contractility of the tubules.

42068 Indomethacin induces rat uterine contractions in vitro and alters reactivity to calcium and acetylcholine. Hargrove, J.L.; Nesbitt, D.; Gaspar, M.J.; Ellis, L.C. (Utah State Univ., Logan). *Am. J. Obstet. Gynecol.;* **124**: No. 1, 25-29(1 Jan 1976).

The initial contractions of uteri in vitro from castrated, estrogen-treated rats were markedly diminished following replacement with fresh bathing medium. Indomethacin and aspirin (10^{-5} to 10^{-4}M) strongly stimulated such quiescent preparations and reduced their subsequent responsiveness to Ca^{++}. Reintroducing the initial bathing medium (which contained prostaglandin-like material), or adding prostaglandin F_2/sub alpha/ to the fresh medium, initiated uterine contractions and restored responsiveness to calcium ion. Injections of indomethacin into castrated, estrogen-treated rats reduced initial in vitro uterine motility, abolished production of prostaglandin-like compounds, and prevented either indomethacin, aspirin, or Ca^{++} from stimulating uterine contractions. Uterine responsiveness to acetylcholine in vitro was significantly reduced in rats pretreated with indomethacin.

42069 Eggs and hatchlings of captive Dipsosaurus dorsalis. Muth, A. (Univ. of Wisconsin, Madison). *Copeia;* No. 1, 189-190(16 Mar 1977).

A breeding colony of D. dorsalis has been established as part of a study of the temperature and moisture requirements of lizard eggs. The lizards are maintained in cages with a 24-hour photothermal period. Mating has been observed in the colony. A summary of clutch size, female snout-vent length and post-laying (3 to 12 hr) body weight are given in a table. Eggs were laid on the surface or in burrows readily observed through the plexiglass cage bottoms. Subsequent sifting of the sand never revealed eggs laid between these extremes. All eggs (N = 40) were found within 1 to 12 hours of laying. The eggs (N = 16) laid in burrows were smooth, translucent white and resilient. The red embryo disc could be observed through the shell. The clutches laid on the sand surface rapidly dehydrated resulting in a yellow, wrinkled and concave appearance. Eggs with sand packed around them from a poorly constructed (eggs partially covered by sand pushed into egg chamber) or collapsed burrow were also yellow and wrinkled but were flaccid instead of firm. Attempts made to rehydrate the eggs laid on the surface (N = 9) and in collapsed burrows (N = 15) were unsuccessful. No further attempts to hatch these eggs were made. When a clutch was found, the burrow was carefully excavated and the eggs were transferred without rotation of the minor axis to incubation chambers. An isopiestic technique was used to control the water potential within the incubation chamber. The eggs were incubated at 36.5 C (+-.4) and at water potentials of -0.25, -0.50, -0.75 and -1.00 bar (N = 4 at each water potential used). Of the 16 eggs incubated, one (-0.75 bar treatment) failed to hatch. Incubation time varied from 43 to 45 days (mean 43.4, S.D. 0.74) and does not appear to be correlated with the water potential used. Measurements were taken within 4 hours of hatching. The mean hatchling weight and snout-vent length were 4.62 gm (S.D. 0.52) and 4.74 cm (S.D. 0.12), respectively.

PUBLIC HEALTH

REFER ALSO TO CITATION(S) 41992

BIOMEDICAL SCIENCES, APPLIED STUDIES

RADIATION EFFECTS

42070 Study of haemopoietic microenvironment in vitro. van Zant, G.E.; Goldwasser, E.; Baron, J.M. *Nature (London);* **260**: No. 5552, 609-611(15 Apr 1976).

The data presented here permit several conclusions with respect to an understanding of the haemopoietic inductive microenvironment. The role of the spleen in promoting erythropoiesis of mouse bone marrow cells can be studied in vitro. Two different mechanisms seem to augment haemoglobin synthesis by splenic tissue. One concerns the existing level of haemoglobin formation by normal marrow cells; the second concerns the increase in response to added erythropoietin. The action of normal spleen cells on baseline haemoglobin synthesis can be duplicated partially by cells which have been frozen rapidly and thawed, making it likely to be an effect of a cell constituent rather than of viable cells. Mouse spleen cells can affect the baseline haemoglobin synthesis of rat marrow cells. The action of either normal spleen cells or cells from the spleens of irradiated mice potentiates the action of erythropoietin or haemoglobin synthesis, but this effect is restricted to intact cells.

RADIATION EFFECTS ON CELLS

EXTERNAL SOURCE

42071 Inhibition of erythroid cell growth in irradiated mice by allogeneic lymphoid cells: specificity of the response. Lundegardh, G.; Lilliehook, B.; Blomgren, H. (Karolinska Institutet, Stockholm). *Cell. Immunol.;* **22**: No. 2, 389-393(15 Mar 1976).

Allogeneic lymphocytes can inhibit proliferation of erythroid cells in the spleens of irradiated mice grafted with syngeneic bone marrow cells. Since there is a linear relationship between the number of injected lymphocytes and erythroid activity, the method is frequently used as a graft-vs-host assay. In this investigation we show that the reduction of erthyroid activity is due to both a reaction of the lymphocytes against the tissues of the host and against the grafted bone marrow cells. Thus, reduced erythropoietic activity does not necessarily indicate that the bone marrow targets possess antigens against which the lymphocytes are reactive.

42072 Pulse radiolytic investigation of single heme group reduction in human methemoglobin. Clement, J.R.; Lee, N.T.; Klapper, M.H.; Dorfman, L.M. (Ohio State Univ., Columbus). *J. Biol. Chem.;* **251**: No. 7, 2077-2082(10 Apr 1976).

Reduction of one of the four heme groups of human aquomethemoglobin A has been investigated by the pulse radiolysis method. The reactivity of e^-/sub aq/, the hydrated electron, with methemoglobin was determined by observing this species directly. The separate reactions of the hydroxyl radical and hydrogen atom, as well as of e^-/sub aq/, were studied by observing absorbance changes in the protein spectrum over the wavelength range 290 to 600 nm, with appropriate scavengers in solution. In unbuffered aqueous solutions at pH 6.2, 0.1 M NaCl, at 23°, the rate constants for the disappearance of e^-/sub aq/ and the reduction of heme, as measured by the absorbance increase at 435 nm, were found to be the same, namely 4.2×10^{10} M^{-1} s^{-1} calculated on the basis of tetramer concentration. Fifty-five percent of the hydrated electrons formed were effective in reducing the heme iron. The rate constants for the reaction of e^-/sub aq/ with cyanomethemoglobin, azidomethemoglobin, and deoxyhemoglobin were also determined and were all found to have values similar to that of aquomethemoglobin. The hydroxyl radical does not appear to contribute to this fast heme-reduction process. However, on a time scale of 100 μs and longer, spectral observations in N_2O-saturated solution reveal that about one-tenth of the hydroxyl radicals do result in reduction of the heme group. This suggests that OH produces a radical intermediate capable of reducing the heme of the protein.

42073 Analysis of the developmental stage of specific and nonspecific cytotoxicity. I. Separation of the developmental steps of specific cytotoxicity by susceptibility to irradiation. Taniguchi, K.; Nomoto, K.; Sato, M.; Yano, Y.; Takeya, K. (Kyushu Univ., Fukuoka). *Cell. Immunol.;* **25**: No. 2, 228-236(Aug 1976).

Susceptibility of T-cell-mediated cytotoxicity to x irradiation was examined in the stages of induction and expression. C3H/He mice and a methylcholanthrene-induced sarcoma of C57BL/6 origin were used for experiments. Established cytotoxicity was radioresistant. Irradiation of hosts before tumor inoculation suppressed induction of cytotoxicity. Irradiation at 3 hr after tumor inoculation or later did not affect induction of cytotoxicity. Cytotoxicity became detectable on day 7 but not on day 3, when mice were irradiated 3 hr after tumor inoculation. Tumor resection abolished cytotoxicity when carried out 24 hr after tumor inoculation but not when carried out on day 3 or later. Sonicated antigen of tumor cells proved to be effective in raising the radioresistant state in the hosts, since cytotoxicity was detectable in those given irradiation 3 hr and viable tumor cells 6 hr after the priming. The radioresistant nature of cytotoxicity may be acquired within a very short period after immunization. However, development of killer cells from such a radioresistant state requires further antigen stimulation with viable tumor cells for a limited period, and maturation of such cells requires some latent period thereafter.

RADIATION EFFECTS ON MICROORGANISMS

BASIC STUDIES

42074 (SAND—77-0426) **Beneficial Uses Program progress report, period ending December 31, 1976.** (Sandia Labs., Albuquerque, N.Mex. (USA)). Mar 1977. Contract EY-76-C-04-0789;EPA-INA-E(29-2)-3536;EPA-IAG-D6-0675. 48p. Dep. NTIS, PC A03/MF A01.

Progress is reported on a comprehensive program to develop the necessary technologies for cost/beneficial uses of existing and future surplus radioactive materials. The major portion of the work was concentrated on the testing of the effectiveness of γ sources for the processing of sewage sludge to inactivate enteric viruses and bacteria and the subsequent testing of the biological effects of the treated sludge when used as fertilizer or additives to animal feeds.

FOOD PRESERVATION

42075 (AD-A—030785) **Result of the assay of radiation sterilized beef for induced radioactivity. Technical report.** Martin, T.G. III; Becker, R.L. (Army Natick Research and Development Command, Mass. (USA). Food Engineering Lab.). Sep 1976. 40p. (FEL—56). NTIS $4.00.

Samples of beef sterilized by ionizing radiation were assayed using a NaI(Tl) detector and a multichannel analyzer to determine if measurable quantities of radioactivity had been induced during the irradiation process. The spectra obtained from each of two hundred sixty-one irradiated samples were compared with those obtained from 25 unirradiated controls, and no evidence of induced radioactivity was noted. Averaged spectra from irradiated samples, controls and the differences are presented in an appendix. Computer programs used in the data reduction are described briefly and the mechanisms of activation, if any, are reviewed. (Author) (GRA)

RADIATION EFFECTS ON ANIMALS

MAN

42076 (BNWL-SA—5966) **Radiological physics and dosimetry research with a small positive ion accelerator.** Wilson, W.E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Oct 1976. Contract E(45-1)-1830. 20p. (CONF-761059—18). Dep. NTIS $3.50.

From 4. annual conference on the use of small accelerators; Denton, Texas, United States of America (USA) (25 Oct 1976).

The distribution of energy along and around the path of charged particles is the fundamental determinant of the chemical and biological effects of ionizing radiation. This energy is deposited initially in a relatively small number of excited molecules lying generally close to the path of the secondary charged particles. This discreet initial structure of the track is of special importance to radiological research. The task confronting the radiation physicist is to develop a comprehensive description, on a microscopic scale, of the primary energy depositions prevailing when a radiation field interacts on biological matter. In view of the inhomogeneity and complexity of this system, this is a monumental task. This paper reviews the current status for measuring directly the energy deposition in simulated biological matter. Inasmuch as current radiobiological information indicates that the sensitive volume is very small, diameter of order 1 μm or smaller, deposition in volumes of this dimension are of primary interest. Limitations of experimental techniques make the direct measurement of energy deposition in such small volumes difficult and hence very uncertain. A Monte Carlo method for calculating this discreet initial track structure is discussed. The input data for calculations of microscopic energy depositions are double differential cross sections for electron ejection by energetic ions. The current status of the experimental measurement of these cross sections is reviewed.

42077 (UR—3490-1072) **Biological effects of low levels of radiation exposure.** Casarett, G.W. (Rochester Univ., N.Y. (USA). School of Medicine and Dentistry). 1977. Contract EY-76-C-02-3490. 29p. (CONF-770208—1). Dep. NTIS, PC A03/MF A01.

From Symposium on public health aspects of radioactivity in consumer products; Atlanta, Georgia, United States of America (USA) (2 Feb 1977).

Some general perspective is provided concerning the orders of radiation dose equivalent levels associated with exposure of human populations to ionizing radiations from consumer products. This is followed by considerations of the biological effects and risks of low levels of radiation exposure. Some consumer products emit low-LET (i.e., low linear energy transfer) radiations beyond their confines and these penetrating radiations can result virtually in whole-body irradiation, while in the case of other products the radiation to tissue consists mainly of the high-LET alpha particles which penetrate tissue only shallowly and close to the products. There are some radiation-emitting consumer products which are in such widespread use in the United States that large numbers of people are irradiated by them. Some of these products may irradiate on the order of 10^6 to 10^8 people to average annual whole-body or gonadal dose equivalents varying over a range on the order of 1 to 10 millirem (mrem). These include television receivers, time pieces with radium-containing dials, gas and aerosol detectors, and building and road construction materials. On the order of 10^4 people may be irradiated by vacuum high voltage switches to 30 mrem or from electron microscopes to 300 mrem average annual whole-body or gonadal dose equivalent. Smaller annual whole-body or gonadal dose equivalents, of the order of less than 1 microrem (μrem) to 1 mrem, may be received by many people from cold cathode gas discharge tubes, airport x-ray inspection systems, time pieces with dials containing tritium or ^{147}Pm, and other sources. Possible health hazards are discussed.

VERTEBRATES

REFER ALSO TO CITATION(S) 42118, 42130

42078 (PB—258436) **Quadrennial report of the division of biological effects, 1971—1974.** Shore, M.L. (Bureau of Radiological Health, Rockville, Md. (USA)). Jul 1976. 164p. (DHEW/PUBL/FDA—76/8058;FDA/BRH—76/123). NTIS $6.75.

The report summarizes activities of the Division of Biological Effects from January 1971 through December 1974. Studies on the biological effects of exposure to ionizing and nonionizing radiation and to ultrasound, particularly emissions from electronic products, are supported by the division's two branches, the Experimental Studies Branch and the Epidemiologic Studies Branch. Investigations at the Collaborative Radiological Health Laboratory sponsored by the division and Colorado State University are described. Published papers and papers prepared for oral presentation are listed. (GRA)

42079 (UCD—472-123, pp 28-44) **Pathology in a lifespan study of x-irradiated adult female beagles.** Chrisp, C.E.; Phemister, R.D.; Andersen, A.C.; Rosenblatt, L.S.; Goldman, M. 1976.

In Annual report, fiscal year 1976.

Both neoplastic and non-neoplastic disease contributed to decreased dose-related cumulative survival rates in female beagles exposed to various doses and dose rates of x radiation at one year of age. Increased dose-related cumulative incidence rates of deaths due to mammary tumors was seen in nulliparous but not in parous beagles. A markedly dose-related increase in incidence of uterine polyps was found. The importance of ovarian, thyroid, urinary bladder, and other neoplasms is discussed.

42080 (UCD—472-123, pp 50-52) **Fractionated x-irradiation damage to developing ovaries in the bonnet monkey (Macaca radiata).** Andersen, A.C.; Hendrickx, A.G. 1976.

In Annual report, fiscal year 1976.

Fractionated x-ray exposures of 11.5 rads each (total 200 rads) given twice weekly between 75 to 137 days postcoitum (pc) severely damaged the ovary of 8 out of 9 fetal bonnet monkeys. This radiation regimen delayed oogenesis in some instances and reduced follicle counts by 75 percent or more. Fractionated x-irradiation earlier in gestation (148 to 104 da pc) did not cause ovarian damage.

42081 (UCD—472-123, pp 67-82) **Hematopoietic effects.** Wilson, F.D.; Stitzel, K.A.; Munn, S.L. 1976.

In Annual report, fiscal year 1976.

Progress is reported on studies on the internal radiation effects of ^{90}Sr and ^{226}Ra in beagles and investigation of leukemias induced by various doses of whole-body ^{60}Co γ. Newer studies on health effects of non-nuclear energy production, in particular the response of macrophage progenitors to particulate fly ash, are described. Previously developed bone marrow cloning techniques, which allow quantitation of bone marrow cell progenitors in vitro, were modified for quantitation of progenitors of alveolar macrophages. In view of the potential importance of silica components in particulate fly ash and the use of silica as an immunosuppressive agent during bone marrow transplantation therapy in experimental leukemia, pilot studies were initiated to investigate the effects of iv-administered silica on bone marrow, lymphoid, and macrophage cell populations in mice and dogs.

42082 **Control of IgE and IgGl antibody production in mice.** De Macedo, M.S.; Braga, F.; Mota, I. (Instituto Butantan, Sao Paulo, Brazil). *Cell. Immunol.;* **23**: No. 2, 342-355(May 1976).

The production of IgE and IgCl was studied in untreated, thymectomized, splenectomized, anti-thymocyte serum-treated, or sublethally X-irradiated mice. Dinitrophenyl, Ascaris, and ovalbumin were used as antigens, and aluminum hydroxide was used as adjuvant. A suppression of IgE production was observed in adult thymectomized mice, although the kinetic pattern of the antibody response was the same as in control animals. IgGl antibody production was not affected by thymectomy. Splenectomy did not change

either IgE or IgGl production. A single dose of rabbit antithymocyte serum (ATS) given 8 days after immunization inhibited IgE antibody production. The effect of ATS was dose dependent and also varied with the amount of antigen used, the immune response to high doses being more susceptible to the effect of ATS. No alteration in IgGl production was caused by ATS even when IgE antibody formation was completely inhibited. When preceding immunization, sublethal irradiation enhanced IgE antibody formation and partially suppressed IgGl production; applied after immunization, irradiation caused an enhancement of IgE production which was inversely proportional to the interval elapsed between the two procedures. On the other hand, the IgGl antibody production was fairly resistant to the same treatment. The results suggest a clearcut separation between the mechanisms regulating IgE and IgGl production in mice.

42083 **Photosensitizing effects of 8-methoxypsoralen on the skin of hairless mice. I. Formation of interstrand cross-links in epidermal DNA.** Ley, R.D.; Grube, D.D.; Fry, R.J.M. (Argonne National Lab., IL). *Photochem. Photobiol.;* **25**: 265-268(1977).

The photomediated induction of interstrand cross-links by 8-methoxypsoralen has been measured in the epidermal DNA of hairless mice. Equivalent efficiencies for cross-link induction were determined for HRS/J/Anl and SKH: hairless-1 mice. A wavelength dependence on the relative efficiency of cross-link induction was observed; a broad spectrum light source, 300—400 nm, was approximately 5 times more effective in cross-link formation than a 365 nm light source. Repeated exposure to 8-methoxypsoralen followed by ultraviolet light, 5 times a week for 6 weeks, altered epidermal thickness and resulted in a decreased efficiency for DNA cross-link formation.

RADIONUCLIDE EFFECTS - INTERNAL SOURCE

MAN

42084 (CONF-770101—2) **Need for collection of quantitative distribution data for dosimetry and metabolic modeling.** Lathrop, K.A. (Chicago Univ., Ill. (USA). Dept. of Radiology; Franklin McLean Memorial Research Inst., Chicago, Ill. (USA)). 1976. Contract EY-76-C-02-0069. 8p. Dep. NTIS, PC A02/MF A01.

From 7. symposium on sharing of computer programs and technology in nuclear medicine; Atlanta, Georgia, United States of America (USA) (16 Jan 1977).

Problems in radiation dose distribution studies in humans are discussed. Data show the effective half-times for ^{7}Be and ^{75}Se in the mouse, rat, monkey, dog, and human show no correlation with weight, body surface, or other readily apparent factor that could be used to equate nonhuman and human data. Another problem sometimes encountered in attempting to extrapolate animal data to humans involves equivalent doses of the radiopharmaceutical. A usual human dose for a radiopharmaceutical is 1 ml or 0.017 mg/kg. The same solution injected into a mouse in a convenient volume of 0.1 ml results in a dose of 4 ml/kg or 240 times that received by the human. The effect on whole body retention produced by a dose difference of similar magnitude for selenium in the rat shows the retention is at least twice as great with the smaller amount. With the development of methods for the collection of data throughout the body representing the fractional distribution of radioactivity versus time, not only can more realistic dose estimates be made, but also the tools will be provided for the study of physiological and biochemical interrelationships in the intact subject from which compartmental models may be made which have diagnostic significance. The unique requirement for quantitative biologic data needed for calculation of radiation absorbed doses is the same as the unique scientific contribution that nuclear medicine can make, which is the quantitative in vivo study of physiologic and biochemical processes. The technique involved is not the same as quantitation of a radionuclide image, but is a step beyond.

42085 (HASL—318) **Health and Safety Laboratory environmental quarterly, December 1, 1976—March 1, 1977.** Hardy, E.P. Jr. (Energy Research and Development Administration, New York (USA). Health and Safety Lab.). 1 Apr 1977. 198p. Dep. NTIS, PC A12/MF A01.

Separate abstracts were prepared for four sections of this report that gives data on fallout radioactivity in environmental samples from throughout the world, Pb content in surface air samples, Pu deposits at the Rocky Flats plant, and chemical effects of SF_6 and Freon-II in the stratosphere. (CH)

42086 (UCD—472-123, pp 120-121) **Dose limitations to humans from ^{129}I.** Book, S.A. 1976.

In Annual report, fiscal year 1976.

From metabolic data on humans, suppression of thyroidal uptake of ^{129}I was predicted, and doses subsequently were calculated. Doses were estimated to be on the order of 7 mrem/nCi ^{129}I up to single oral dosages of 1 nCi, declining thereafter. Beyond 10 nCi, the dose/nCi decreased markedly, dropping below 1 mrem/nCi at dosages in excess of 1000 nCi.

ANIMALS

REFER ALSO TO CITATION(S) 42081, 42084, 42118, 42127, 42129

42087 (UCD—472-123, pp 85-86) **Immune competence of ^{226}Ra-injected dogs and age-matched controls as measured by the micro-lymphocyte stimulation test.** Shifrine, M.; Taylor, N.J.; DeRock, E.W.; Worthington, B.M. 1976.

In Annual report, fiscal year 1976.

The micro-lymphocyte stimulation test was used to evaluate the immune competance of ^{226}Ra-injected dogs and normal age-matched controls. Ability of lymphocytes to divide was significantly reduced in tumor-bearing ^{226}Ra-injected dogs, and possibly reduced in the oldest ^{226}Ra-injected dogs. The test showed large variability in the oldest normal dogs tested (12.4 to 12.7 yrs old).

42088 (UCD—472-123, pp 90-93) **Clinical case load for radionuclide-treated beagles, calendar year 1975.** Holbrook, C.H.; MacMillan, K.L.; Maslowski, S.F.; Muggli, F.M. 1976.

In Annual report, fiscal year 1976.

Medical and surgical cases among the approximately 500 surviving beagles of the ^{226}Ra/^{90}Sr internal irradiation study are categorized on the basis of body system involved. The substantial increase in case load that occurred during calendar year 1975 (while mortality rates remained stable) is attributed primarily to an increase in spontaneous, rather than radiation-induced, disease conditions in the aging (8 to 15 years old) beagles.

42089 (UCD—472-123, pp 94-103) **Cumulative mortality in radionuclide treated beagles.** Chrisp, C.E.; Pool, R.R.; Spangler, W.; Goldman, M.; Rosenblatt, L.; Wolf, H.G. 1976.

In Annual report, fiscal year 1976.

The first osteosarcoma in the ^{90}Sr injected dose was seen and late occurring myeloproliferative diseases were also seen. Non-radiation induced malignant tumors are assuming increased importance as the colony ages.

42090 (UCD—472-123, pp 104-108) **Canine bone dynamics.** Parks, N.J.; Bradley, E.W.; Tsuboi, K.K.; Abrahams, C.D. 1976.

In Annual report, fiscal year 1976.

The whole-body retention and elimination rate measurements of ^{226}Ra in beagles are incorporated into a mathematical model of bone dynamics, including the age-dependency of cellular-derived bone mineral turnover rates. The model predictions of cancellous/compact bone specific activity ratios are consistent with values reported for humerii from aged beagles with initial ^{226}Ra body burdens less than 6 μCi. The clearance of ^{239}Pu from beagle humerii is also compatible with the model when restrictions on the radionuclide removal by chemical exchange are imposed.

42091 (UCD—472-123, pp 111-113) **^{131}I metabolism in pregnant and fetal guinea pigs.** Book, S.A.; McNeill, D.A.; Berding, K.L. 1976.

In Annual report, fiscal year 1976.

Guinea pigs in the last 2 weeks of gestation were injected with ^{131}I and sacrificed up to 9 days later. From 5 hr to 9 days postinjection, the ^{131}I concentration was less in maternal blood than fetal blood which, in turn, was less than that in amniotic fluid. Three days after injection peak fetal thyroidal concentration was about 200 percent of the injected dose per gram, about 3 times the maternal value. Iodine-131 was released from the fetal thyroid gland with a biologic half-life (T/sub b/) of 3 days. The adult T/sub b/, in comparison, was estimated to be 11 days.

42092 (UCD—472-123, pp 116-117) **Metabolism of ^{129}I in young beagles.** Book, S.A.; McNeill, D.A. 1976.

In Annual report, fiscal year 1976.

Iodine-129 was administered orally to young beagles. As the dosage increased, ^{129}I thyroid uptake and whole-body retention decreased, thereby limiting the radiologic risk associated with assimilation of this long-lived radionuclide.

NUCLIDE KINETICS AND TOXICOLOGY

MAN

42093 (BNWL—2088) **Proceedings of the workshop on measurement of heavy elements in vivo.** Swinth, K.L. (ed.). (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1976. Contract E(45-1)-1830. 247p. (CONF-760697—). Dep. NTIS $9.00.

From Workshop on measurement of heavy elements in vivo; Seattle, Washington, United States of America (USA) (24 Jun 1976).

Separate abstracts were prepared for 22 papers that discuss methods for the external measurement of transuranium elements deposited in personnel.

42094 (BNWL—2088, pp 1-10) **Plutonium problem in biological perspective.** Marks, S. (Battelle-Pacific Northwest Labs., Richland, WA). Sep 1976.

From Workshop on measurement of heavy elements in vivo; Seattle, WA, USA (24 Jun 1976).

In Proceedings of the workshop on measurement of heavy elements in vivo.

A brief summary is presented of some relevant results of animal studies on the biology of Pu that are concerned mostly with the location and migration of various forms of Pu in the body. The status of human studies, including measurements of the concentration of Pu in tissues of the body after death and the incidents and mortality rates for various diseases in Pu personnel, is discussed. The function of the Transuranium Registry for collecting information about the concentration and distribution of Pu in various organs and tissues and verification of estimates of body-burdens of personnel based on postmortem measurements of tissues obtained at autopsy is summarized.

42095 (BNWL—2088, pp 11-17) **Role of chest counting in personnel dosimetry.** Heid, K.R. (Battelle-Pacific Northwest Labs., Richland, WA). Sep 1976.

From Workshop on measurement of heavy elements in vivo; Seattle, WA, USA (24 Jun 1976).

In Proceedings of the workshop on measurement of heavy elements in vivo.

The use of plutonium in the production of energy is becoming increasingly important. Specifically ^{239}Pu is being used to enrich fuel for power reactors, is being used in heat sources, and as a source of power for prosthetic heart pacers and mechanical heat pumps. As the use of Pu increases, the number of Pu workers or persons potentially exposed to plutonium increases. Each facility handling Pu in significant quantities must have a radiation protection program that includes plans and/or programs to minimize or prevent internal exposure of personnel to Pu. The program, at a minimum, must include methods to estimate Pu deposited in the body or to establish a basis for judgement that significant depositions have not occurred. The effectiveness of external counting for measurements of ^{238}Pu or ^{239}Pu deposited in the respiratory tract is discussed.

42096 (BNWL—2088, pp 19-37) **Calibration techniques and error analysis for phoswich counting of actinide nuclides at Oak Ridge National Laboratory.** Goans, R.E.; Good, W.M. (Oak Ridge National Lab., TN). Sep 1976.

From Workshop on measurement of heavy elements in vivo; Seattle, WA, USA (24 Jun 1976).

In Proceedings of the workshop on measurement of heavy elements in vivo.

One of the most difficult and demanding areas of low-level counting is the detection of actinides in vivo. In the case of inhalation of these nuclides, it is common practice at many installations to determine the resulting lung burden by external counting of low-intensity L X-rays from the daughter nucleus with either a phoswich detector or a proportional counter. Calibration techniques using these detectors are examined and possible uncertainties in the determination of lung burden by using standard techniques are discussed. The use of phoswich detectors is discussed in detail.

42097 (BNWL—2088, pp 53-62) **Use of ^{103}Pd as a calibration source for the determination of ^{239}Pu in vivo.** Toohey, R.E. (Argonne National Lab., IL). Sep 1976.

From Workshop on measurement of heavy elements in vivo; Seattle, WA, USA (24 Jun 1976).

In Proceedings of the workshop on measurement of heavy elements in vivo.

Questions that arise concerning the use of ^{103}Pd as a calibration source for in vivo ^{239}Pu are discussed. Although the energies of the rhodium K/sub α/ and uranium L/sub γ/ x rays are identical at 20.2 keV, the effect of the rhodium K/sub β/ line at 22.8 keV must be considered. The effects of backscattering and calibration factors for ^{239}Pu from data obtained from ^{103}Pd in vivo are discussed.

42098 (BNWL—2088, pp 63-80) **Error analysis and propagation of uncertainties for the measurement of inhaled transuranium elements.** Falk, R.B. (Atomics International Div., Golden, CO). Sep 1976.

From Workshop on measurement of heavy elements in vivo; Seattle, WA, USA (24 Jun 1976).

In Proceedings of the workshop on measurement of heavy elements in vivo.

Measurement of inhaled transuranium elements is accomplished by counting photons emitted from inhaled radioactive materials using detectors placed against the chest, sides, or back of the subject. The uncertainty in the measured amount of the inhaled material depends upon the uncertainties resulting from an intangible source geometry and from attenuation in the subject's body, as well as upon the statistics of obtaining a net positive count. A method of error analysis is presented to deal with the uncertainties from the various sources of error to yield the propagated uncertainty in the measured values of the amount of the inhaled activity.

42099 (BNWL—2088, pp 81-84) **Determination of heavy elements in humans.** Olson, D.G. (Energy Research and Development Administration, Idaho Falls, ID). Sep 1976.

From Workshop on measurement of heavy elements in vivo; Seattle, WA, USA (24 Jun 1976).

In Proceedings of the workshop on measurement of heavy elements in vivo.

The uncertainties associated with the determined measurement of lung burdens of transuranium elements become important when positive results are obtained. A lung burden of 16 nCi of ^{239}Pu with no uncertainty was reported for one individual on each of three different counts. Because the uncertainty was not reported it was impossible to evaluate the exposure with any degree of confidence. The result could mean that one lung burden of activity has been determined or it could mean that the detection limit for the method has not been exceeded and so the person has no measurable activity. An alternate method of measuring ^{239}Pu in the body is to separate and count the ^{239}Pu excreted in the feces or the urine. An assumption must be made about how the eliminations from the body represent the material deposited inside the body. Although uncertainties do exist in this assumption the advantage over chest counting is that the detection limit is only 0.002 of a maximum permissible lung burden instead of being a one permissible burden.

42100 (BNWL—2088, pp 85-87) **Summary of discussion calibration techniques and errors I.** Tomlinson, F.K. Sep 1976.

From Workshop on measurement of heavy elements in vivo; Seattle, WA, USA (24 Jun 1976).

In Proceedings of the workshop on measurement of heavy elements in vivo.

Some of the problems that are yet to be solved in the measurement of heavy elements in vivo are reviewed. A current area of general concern is in the agreement of lung deposition assessments between various lung counter facilities. The solution of this problem, which has decreased in magnitude over the past 6 years, relates directly to the calibration of each lung counter.

42101 (BNWL—2088, pp 89-100) **Calibration for plutonium-238 lung counting at Mound Laboratory.** Tomlinson, F.K. (Mound Lab., Miamisburg, OH). Sep 1976.

From Workshop on measurement of heavy elements in vivo; Seattle, WA, USA (24 Jun 1976).

In Proceedings of the workshop on measurement of heavy elements in vivo.

The calibration technique for lung counting of ^{238}Pu at Mound Laboratory is somewhat similar to those used at some other contractors of the Energy Research and Development Administration. However, some portions of Mound Laboratory's technique are unique. The primary purpose of this paper is to present the details of how we calibrate the lung counter facility. Calibration is not complete without an analysis of the errors involved and the calculation of the minimum detectable activity. Following the calibration technique used at Mound Laboratory is an explanation of the errors included, those not included, the method of determining minimum detectable activity, and finally a typical example of how the calibration curve and errors are used in making an uptake assessment.

42102 (BNWL—2088, pp 101-106) **Calibration techniques for the in vivo measurement of alpha-emitting actinides.** Fleming, R.R. (Savannah River Plant, Aiken, SC). Sep 1976.

From Workshop on measurement of heavy elements in vivo; Seattle, WA, USA (24 Jun 1976).

In Proceedings of the workshop on measurement of heavy elements in vivo.

Reliable interpretation of in vivo measurements for alpha-emitting actinides deposited in the lungs is largely dependent on three factors: correction of observed count rates for background contributions; correction for photon absorption in the body; and accurate calibration of the counting system. Terrestrial and cosmic radiation contributions can be minimized by extensive shielding and good pulse-shape discrimination. Techniques are available to minimize errors inherent in the calibration of an in vivo counting system. Minimum amounts of alpha-emitting actinides detectable in the lungs are primarily affected by the accuracy of two factors: predicted body background due to ^{137}Cs and ^{40}K, and estimated photon absorption in chest-wall tissue. A matched pair of 12.5-cm-dia phoswich detectors, purchased from the Harshaw Chemical Company, are used to measure low-energy photons emitted by the radioactive actinides.

42103 (BNWL—2088, pp 107-123) **Measurement of transuranic elements in vivo at CRNL.** Johnson, J.R. (Chalk River Nuclear Labs., Ont.). Sep 1976.

From Workshop on measurement of heavy elements in vivo; Seattle, WA, USA (24 Jun 1976).

In Proceedings of the workshop on measurement of heavy elements in vivo.

The isotopes of interest as potential inhalation hazards to persons working in the mixed oxide fuel fabrication plant are mainly

^{238}Pu, ^{239}Pu, and ^{240}Pu, and with time, ^{241}Am, as it grows in from the decay of ^{241}Pu. The plutonium isotopes do not emit any radiation during decay capable of penetrating to the outside of the chest from the lungs in measurable quantities other than the L X-rays of uranium. These X-rays are of low relative abundance and are highly attenuated as they pass through the chest wall. A measurement of a subject's chest for lung burdens of these isotopes at or below the maximum permissible lung burden of 16 eta Ci essentially consists of measuring the subject's background in the L X-ray energy region and comparing the measured value to a predicted value. A calibration factor that depends on the isotopic ratios of the deposited radioactive material, the pattern of the deposition, and the attenuation of the L X-rays in the tissue between the deposited material and the detectors is then applied to the difference between the measured and predicted background to obtain an estimate of the lung burden for this subject. The performance of the phoswich detectors and statistical parameters that can be used to describe the background for uncontaminated subjects, which can then be used as aids in predicting the background of suspected contaminated subjects, were evaluated.

42104 (BNWL—2088, pp 125-131) **In vivo plutonium measurement at the Battelle-Northwest whole body center.** Palmer, H.E.; Rieksts, G.A.; Houston, J.R. (Battelle-Pacific Northwest Labs., Richland, WA). Sep 1976.

From Workshop on measurement of heavy elements in vivo; Seattle, WA, USA (24 Jun 1976).

In Proceedings of the workshop on measurement of heavy elements in vivo.

Lung counting is a major part of the in vivo counting for internal contamination in the Hanford project employees. Approximately 1,100 of the 4,000 counts made at the Battelle-Northwest whole body counting facilities in 1975 were lung counts in which plutonium is the main radionuclide of interest. For a 250-working-day-year, the average number of lung counts per day is between four and five but as many as ten lung counts are often done in a single eight-hour day. This use rate requires that the detectors and instrumentation be reliable and stable during the course of the day since there is not time to check the calibration and response of the system between each count. Although phoswich detectors have been in use at the counter facilities for several years, the pulse-shape analysis instrumentation has not had sufficient stability and reliability for use in the routine lung counting program. The phoswich detectors are used in special cases of positive lung contamination to help identify and quantify the deposited material. The method for determining plutonium in the lungs depends on the use of large NaI(Tl) detectors for measurement of the 60 keV gamma ray from ^{241}Am, which is associated with almost all ^{239}Pu on the Hanford project. The ratio of ^{239}Pu to ^{241}Am in the inhaled material is determined by alpha energy analysis of air filter, nasal smear, and, if necessary, fecal samples. For ^{238}Pu or pure ^{239}Pu, which does not contain ^{241}Am from the decay of ^{241}Pu, the 17 keV uranium L X-rays are measured with the phoswich detector system.

42105 (BNWL—2088, pp 133-149) **LLL plutonium lung counter calibration and discussion of errors.** Anderson, A.L.; Campbell, G.W. (Lawrence Livermore Lab., CA). Sep 1976.

From Workshop on measurement of heavy elements in vivo; Seattle, WA, USA (24 Jun 1976).

In Proceedings of the workshop on measurement of heavy elements in vivo.

The Whole Body Counter at Lawrence Livermore Laboratory is located in a shielded room 6.1 metres underground, and is equipped with a filtered air supply to remove approximately 99 percent of the radioactivity present from radon-thoron daughters in the air. Two Harshaw Phoswich detectors 120 mm in diameter are presently used for lung counting. These are placed high on the chest tangent to the sternum and clavicle. The front face of the detector consists of a 1.6-mm-thick NaI(Tl) scintillation crystal with a 0.25-mm beryllium window, and is used as the X-ray detector. This is backed by a thicker 38.1-mm CsI(Na) crystal coupled to the same photomultiplier tube. This crystal is used for compton background suppression, and also to provide spectral information over the energy range from 100 keV to 2.5 MeV. The detector outputs, using risetime discrimination electronics, can be summed or accumulated separately in a pulse height analyzer. An Alderson Remab phantom is used for calibration. This is a take-apart phantom which has a human skeleton and fillable compartments to simulate the body organs. The lung cavities, which are shown in the figure, can be filled with lung-equivalent material containing radioactive standards for calibration. Several uniformly loaded sets of these lungs have been made incorporating various isotopically pure radionuclides including ^{238}Pu, ^{239}Pu, and ^{241}Am.

42106 (BNWL—2088, pp 151-156) **Present status of and future plans for ITRI's human and dog chest counting facilities.** Stanley, J.A.; Mewhinney, J.A. (Lovelace Foundation for Medical Education and Research, Albuquerque, NM). Sep 1976.

From Workshop on measurement of heavy elements in vivo; Seattle, WA, USA (24 Jun 1976).

In Proceedings of the workshop on measurement of heavy elements in vivo.

Chest counting of actinide lung burdens on humans and dogs at ITRI began with the installation of a dual detector phoswich system in 1970. The system made use of pulse-shape discrimination circuitry and employing the leading edge-to crossover timing principle.

42107 (BNWL—2088, pp 161-178) **Estimation of lung and skeletal burdens of bone-seeking radionuclides in man from in vivo scintillation measurements of the thorax and the head.** Cohen, N.; Spitz, H.B.; Laurer, G.R.; Wrenn, M.E. (New York Univ. Medical Center, NY). Sep 1976.

From Workshop on measurement of heavy elements in vivo; Seattle, WA, USA (24 Jun 1976).

In Proceedings of the workshop on measurement of heavy elements in vivo.

Although measurements of the concentration of actinides in excreta of personnel may indicate whether an exposure has occurred and, if the time of exposure is known, may permit an estimate of the approximate magnitude of the intake, bioassay measurements usually cannot be used to reliably establish absolute values of a systemic burden, specific deposition sites, or the presence of nontransportable material in the lung. For these reasons, in vivo measurement techniques in conjunction with excreta bioassay have been used more extensively and with increasing sophistication. Utilization of in vivo head counting techniques holds considerable promise for estimating the total skeletal burden of various bone-seeking nuclides more easily and with greater precision than has been possible in the past. Once the skeletal content of activity has been determined, it will be possible to estimate the amount of rib, sternum, and vertebrae activity that contributes to in vivo thorax measurements. This, in turn, will provide extremely useful data for estimating the partition of activity between the lung and these bone structures. It should be assumed that any estimate of bone-seeking radionuclide activity in the lung that has been made from in vivo scintillation counting will be derived from measurements made over the head as well as over the thorax.

42108 (BNWL—2088, pp 179-196) **Methods for the assay of plutonium in vivo: what are the alternatives.** Rundo, J.; Strauss, M.G.; Sherman, I.S.; Brenner, R. (Argonne National Lab., IL). Sep 1976.

From Workshop on measurement of heavy elements in vivo; Seattle, WA, USA (24 Jun 1976).

In Proceedings of the workshop on measurement of heavy elements in vivo.

The problem of estimating the amount of plutonium in the human body in vivo is of considerable importance in view of the major role Pu may play in the future nuclear power program. It is a particularly difficult one because the ^{238}Pu and ^{239}Pu present in reactor-grade material emit virtually no penetrating radiation, so that conventional methods of body radioactivity measurement are useless. The existing methods of estimating Pu body burdens are reviewed and alternatives are suggested. Emphasis is placed on Pu in lung, the major problem, but reference is also made to systemically deposited Pu. Both indirect and direct methods are discussed.

42109 (BNWL—2088, pp 197-198) **Development of an improved counter for in vivo plutonium measurement.** Palmer, H.E. (Battelle-Pacific Northwest Labs., Richland, WA). Sep 1976.

From Workshop on measurement of heavy elements in vivo; Seattle, WA, USA (24 Jun 1976).

In Proceedings of the workshop on measurement of heavy elements in vivo.

A relatively new counter was developed for measurement of Pu in vivo which has the potential of providing a large detecting area and significantly improved resolution which should result in a more sensitive instrument for measuring Pu both in vivo and in the environment. This gas scintillation proportional counter contains pure xenon gas and has a scintillation light output which is 100 times that of NaI(Tl) per unit of absorbed photon energy. With a collimated beam of low energy gamma or X-rays (from 0.1 to 100 keV) the resolution is about ten times better than that obtained from thin crystal NaI(Tl) detectors and two times better than ordinary proportional counters.

42110 (BNWL—2088, pp 199-205) **Effects of plutonium redistribution on lung counting.** Swinth, K.L. (Battelle-Pacific Northwest Labs., Richland, WA). Sep 1976.

From Workshop on measurement of heavy elements in vivo; Seattle, WA, USA (24 Jun 1976).

In Proceedings of the workshop on measurement of heavy elements in vivo.

Early counts of Pu deposition in lungs will tend to overestimate lung contents since calibrations are performed with a uniform distribution and since a more favorable geometry exists in contaminated subjects because the activity is closer to the periphery of the lungs. Although the concentration into the outer regions of the lungs continues as evidenced by the autopsy studies, the counts performed

by L X-rays will probably underestimate the lung content; because, simplistically, the geometry several years after exposure consists of a spherical shell with a point of activity in the center. This point of activity represents concentration in the lymph nodes from which the 60 keV gamma of ^{241}Am will be counted, but from which few of the L X-rays will be counted (this is an example of interorgan distribution). When a correction is made to the L X-ray intensity, the lymph node contribution will tend to increase the amount subtracted while correcting for ^{241}Am X-rays. It is doubtful that the relative increase in X-ray intensity by concentration in the pleural and sub-pleural regions will compensate for this effect. This will make the plutonium burden disappear while the ^{241}Am can still be detected. This effect has been observed in a case where counts with an intraesophageal probe indicated a substantial lymph node burden. In order to improve the accuracy of in vivo plutonium measurements, an improved understanding of pulmonary distribution and of distribution effects on in vivo counting are required.

42111 (BNWL—2088, pp 207-218) **Detection system for the localization and measurement in vivo of small amounts of photon emitters.** Laurer, G.R.; Eisenbud, M.; Cohen, N. (New York Univ. Medical Center, NY). Sep 1976.

From Workshop on measurement of heavy elements in vivo; Seattle, WA, USA (24 Jun 1976).

In Proceedings of the workshop on measurement of heavy elements in vivo.

The purpose of this paper is to describe the design of a photon detection system for whole body in vivo detection and quantitative assessment of body burdens of ^{238}Pu, ^{239}Pu, or ^{241}Am which will simultaneously yield information proportional to both the magnitude and the site(s) of deposition of photon emitters accidentally inhaled, ingested, or otherwise deposited in the body. The operating principle of the detector system, active collimation, results from the use of pulse-shape discrimination and allows spatial resolution (X, Y and Z axes) without the use of separate collimating devices and, hence, with the possibility of increased geometric detection efficiency compared to other collimated systems used to define source position.

42112 (BNWL—2088, pp 219-227) **Ultrasonic measurement techniques used at LLL for determining chest wall thickness and organ shapes.** Campbell, G.W.; Anderson, A.L. (Lawrence Livermore Lab., CA). Sep 1976.

From Workshop on measurement of heavy elements in vivo; Seattle, WA, USA (24 Jun 1976).

In Proceedings of the workshop on measurement of heavy elements in vivo.

Methods used for determination of the amount of transuranic elements deposited in the lungs of personnel are described. A method of ultrasonography has been used which allows better definition of the sub-surface structures within the body, and is potentially a more accurate means of determining tissue thickness. Continous transverse and longitudinal scans are traced over the area which the detectors cover on each side of the chest. The scans are recorded on a storage scope and a hard copy is made. The data from each scan are also recorded on magnetic tape. The magnetic tape is then read into a computer system which displays each scan in 64 colors, where each color is related to an assigned echo intensity.

42113 (BNWL—2088, pp 229-230) **Preliminary evaluations of a high-purity germanium detector system for in vivo measurement of inhaled transuranium elements.** Falk, R.B. (Atomics International Div., Golden, CO). Sep 1976.

From Workshop on measurement of heavy elements in vivo; Seattle, WA, USA (24 Jun 1976).

In Proceedings of the workshop on measurement of heavy elements in vivo.

A body counter system is described that uses two arrays of high-purity (intrinsic) germanium detectors. The capabilities of the system for the measurement of inhaled Pu and Am in personnel are discussed. The system consists of two arrays of four planar, intrinsic Ge detectors each, mounted in downward-looking cryostats. Each of the eight individual detectors is 10 mm deep and 36 mm in diameter and has a useful surface area of approximately 10 cm^2 with a resolution at full-width-half-maximum of better than 650 keV at 60 keV. Data from each detector are collected, separated and processed with a Data General 1220 computer and dual disc system.

42114 (BNWL—2088, pp 235-241) **Development of an anthropomorphic phantom for the calibration of external detectors for the in vivo measurement of plutonium.** Sep 1976.

From Workshop on measurement of heavy elements in vivo; Seattle, WA, USA (24 Jun 1976).

In Proceedings of the workshop on measurement of heavy elements in vivo.

There are many methods of calibrating external detectors for in vivo measurements of Pu in personnel. The most frequently used involve point sources, phantoms, and direct use of exposed humans. It was concluded that the phantoms currently used in calibrating detectors are mostly inadequate since they were not designed for X-ray emitters in the lung. The design and construction of a more realistic phantom is discussed. This phantom will permit a detailed study of the effect on counting efficiency of the distribution of radioactive material in the lung. After the phantom has been carefully studied, it will be circulated among the interested laboratories and hopefully will become a primary standard for the intercalibration program.

ANIMALS

REFER ALSO TO CITATION(S) 42094, 42106

THERMAL EFFECTS

VERTEBRATES

42115 **Use of a cold-water refuge by rainbow and brown trout in a geothermally heated stream.** Kaya, C.M.; Kaeding, L.R.; Burkhalter, D.E. (Montana State Univ., Bozeman). *Prog. Fish-Cult.;* **39**: No. 1, 37-39(Jan 1977).

The Firehole River of Yellowstone National Park receives substantial amounts of geothermally heated water, which raise river temperatures by about 12°C. We have recorded summer temperatures as high as 28.8°C in the lower section of the river. During the warmest part of the summer, rainbow trout (Salmo gairdneri) and brown trout (S. trutta) from the river concentrate in Sentinel Creek, the only cold-water tributary along the lower Firehole River. These movements into the creek appear to be related to mean daily temperatures exceeding 24°C, or daily maximums exceeding 25°C. Aggregations of fish from cooler waters to heated discharge areas have been extensively documented; however, this contrasting situation of fish from a heated body of water concentrating at a cold-water influent area has been reported only once previously and involved a warm-water species.

42116 **Downstream movement of fish in a tributary of southern Lake Superior.** Manion, P.J. (Sea Lamprey Control Station, Marquette, MI). *Prog. Fish-Cult.;* **39**: No. 1, 14-16(Jan 1977).

The influence of two environmental factors, stream flow and water temperature, on the downstream movement of four fish species in the Big Garlic River over a 12-yr period is described. Brook trout (Salvelinus fontinalis) migrated after floods had subsided in the spring and during rising water in the fall at temperatures of about 10°C. Brook sticklebacks (Culaea inconstans) moved downstream chiefly in winter. Mottled sculpins (Cottus bairdi) moved primarily in the winter and during floods. Yellow perch (Perca flavescens) appeared to move generally in the fall as water levels increased and water temperatures decreased.

CHEMICALS METABOLISM AND TOXICITY

42117 (ORNL/EIS—107) **NSF-RANN trace contaminants abstracts.** Harnden, D.S.; Ross, R.H. (eds.). (Oak Ridge National Lab., Tenn. (USA)). Apr 1977. Contract W-7405-ENG-26. 33p. Dep. NTIS, PC A03/MF A01.

References are included to 50 publications during 1975 and 1976 on the environmental transport of trace amounts of toxic substances. (CH)

42118 (UCD—472-123) **Annual report, fiscal year 1976.** Goldman, M. (California Univ., Davis (USA). Radiobiology Lab.). 1976. Contract EY-76-C-03-0472. 179p. Dep. NTIS, PC A08/MF A01.

Separate abstracts were prepared for 22 sections of this report. A list is included of 60 publications during the period covered and tabulated data covers the health status of aging beagles administered ^{90}Sr or ^{226}Ra. (CH)

42119 (UCD—472-123, pp 2-4) **Fractionator for size-classification of aerosolized solid particulate matter.** McFarland, A.R.; Fisher, G.L.; Prentice, B.A.; Bertch, R.W. (Texas A and M Univ., College Station). 1976.

In Annual report, fiscal year 1976.

A system has been developed for collecting kilogram quantities of size-fractionated particulate matter from an air pollution emission source. These quantities are sufficient for use in biologic testing. The apparatus consists of a series of two cyclones and a centripeter and yields four size fractions. When used for 12 days to collect fly ash from stack gas passed through the electrostatic precipitator of a coal-fired power plant, the apparatus yielded a total of 8.08 kg of fly ash in fractions with volume median diameters of 20, 6.3, 3.2 and 2.2 μm (geometric standard deviations of approximately 1.8).

42120 (UCD—472-123, pp 5-10) **Morphology and chemistry of size-classified fly ash collected from the stack of a coal-fired power plant.** Fisher, G.L.; Prentice, B.A.; Silberman, D. 1976.

In Annual report, fiscal year 1976.

The physical and chemical properties of size-classified fly ash collected from the stack of a coal-fired power plant presently are being evaluated. Light and scanning electron microscopic evaluation of four sized fractions with volume median diameters of 2.2, 3.2, 6.3 and 20 μm demonstrate morphological heterogeneity and provide the basis for development of a particle genesis scheme. Chemical analyses of the fly ash fractions indicate increased concentrations of many trace elements with decreasing particle size.

CELLS

42121 (UCD—472-123, pp 23-25) **Development of the chick myoblast culture system for the study of toxicity of fly ash.** Chrisp, C.E.; Lammert, J.E.; Fisher, G.L. 1976.

In Annual report, fiscal year 1976.

The development of the chick myoblast culture system for study of the in vitro toxicity of fly ash from a coal burning power plant is described.

PLANTS

REFER ALSO TO CITATION(S) 40989, 42043

INVERTEBRATES

REFER ALSO TO CITATION(S) 40989

VERTEBRATES

REFER ALSO TO CITATION(S) 40862, 40991, 42081, 42132

42122 (PB—253958) **Physiological effects of sublethal levels of acid water on fish.** Pegg, W.J.; Jenkins, C.R. (West Virginia Univ., Morgantown (USA). Water Research Inst.). May 1976. Contract DI-14-31-0001-3049. 55p. (WRI-WVU—76-01; Bull—6). NTIS $4.50.

Pub. as West Virginia Univ. Bull. Ser-76, No. 11-27, May 1976.

Oxygen-consumption rates as milligrams of oxygen per gram of fish per hour (mg 02/g per hr) were measured in a flow-through respirometer for bluegill sunfish, Lepomis macrochirus Rafinesque; pumpkinseed sunfish, Lepomis gibbosus (Linnaeus); and brown bullheads, Ictalurus nebulosus (LeSueur). Non-stress standard oxygen-consumption rates were established using tap water. L. macrochirus exhibited a decrease in mean oxygen-consumption rates in acid water - 0.081 mg 02/g per hr compared to 0.111 in tap water. L. gibbosus exhibited increased oxygen-consumption rates in acid water - 0.106 mg 02/g per hr compared to 0.082 in tap water. I. nebulosus exhibited lower oxygen-consumption rates in acid water than in tap water - 0.075 mg 02/g per hr compared to 0.124. In acid water (pH 4.0-3.0), ventilation rates were highly variable and frequently increased to three times the standard resting rate. As an indication of physiological stress, the changes in oxygen-consumption rate in acid waters compared to standard tap water were significant for each fish species. (GRA)

42123 (PB—257246) **Effect of hydrogen sulfide on fish and invertebrates. Part II. Hydrogen sulfide determination and relationship between pH and sulfide toxicity. Final report Aug 72—Mar 75.** Broderius, S.J.; Smith, L.L. Jr. (Minnesota Univ., St. Paul (USA). Dept. of Entomology, Fisheries, and Wildlife). Jul 1976. 120p. NTIS, PC A06/MF A01.

See also Part 1, PB—256410.

An analytical method was developed for the direct determination of microgram/liter concentrations of molecular H_2S. The procedure involves bubbling compressed nitrogen through an aqueous sulfide solution to displace H_2S which is collected in a glass bead concentration column and measured colorimetrically. The H_2S concentration is calculated from the determined sulfide displacement rate and by reference to a log linear standard curve relating temperature with the H_2S displacement rate to the H_2S concentration in standard solutions. To permit accurate determination of H_2S from the determined dissolved sulfide concentration and fraction of dissolved sulfide as H_2S for specific conditions of temperature and pH, the apparent linear relationship between pK1 for H_2S(aq) and temperature was defined. This procedure of calculating H_2S in various waters and effluents was confirmed by the direct technique. The described analytical technique was used to define the relationship between test pH and sulfide toxicity to the fathead minnow.

42124 (UCD—472-123, pp 15-18) **Secondary aerosols from power plant effluents: delivery and in vivo detection systems.** Parks, N.J.; Raabe, O.G.; Bradley, E.; Raub, J. 1976.

In Annual report, fiscal year 1976.

An experimental system is described for the generation of radiolabeled monodisperse aerosols, which are physico-chemically analogous to aerosols produced as secondary products of gaseous fossil fuel power plant emissions of SO_2 and NO_2. The experimental system for inhalation exposure of non-human primates to these particles and the in vivo determination of systemic distribution and target organs is discussed.

42125 (UCD—472-123, pp 19-22) **Synthesis of ^{13}N- and ^{35}S-labeled fossil fuel power plant effluents for in vivo distribution studies.** Parks, N.J.; Peek, N.; Theus, R.; Krohn, K.; Tsuboi, K.K. 1976.

In Annual report, fiscal year 1976.

Externally detectable gamma-emitting isotopes of ^{35}S and ^{13}N were produced by proton bombardment in a cyclotron. These isotopes were incorporated into carrier-free sulfate, nitrate and ammonium ions for use in metabolic studies of fossil fuel power plant effluents.

42126 **Aminoaciduria and proteinuria in rats after a single intraperitoneal injection of Ni(II).** Gitlitz, P.H.; Sunderman, F.W. Jr.; Goldblatt, P.J. (Univ. of Connecticut, Farmington). *Toxicol. Appl. Pharmacol.*; **34**: 430-440(1975).

Proteinuria was found in Fischer female rats after a single ip injection of $NiCl_2$ in dosages from 34 to 85 μmol/kg (2 to 5 mg Ni/kg). Generalized α-aminoaciduria was found after a single ip injection of $NiCl_2$ in dosages of 68 to 85 μmol/kg (4 and 5 mg Ni/kg). Amino acids in plasma were normal or slightly diminished from 1 to 48 hr after injection of Ni(II). Electron microscopy of kidneys of five rats at 48 hr after Ni(II) (68 μmol/kg) consistently revealed fusion of foot processes of glomerular epithelial cells. Focal tubular necrosis was present in the kidney of one of these rats. This study demonstrates that toxic nephropathy with aminoaciduria and proteinuria develops in rats after ip Ni(II). Amino acid and protein excretions consistently returned to normal by Day 5.

42127 **Air pollution and the lung.** Aharonson, E.F.; Ben-David, A.; Klingberg, M.A. (eds.). New York; John Wiley and Sons, Inc. (1976). 324p. (CONF-750384—).

From 12. annual OHOLO biological conference; Ma'alot, Israel (16 Mar 1975).

Separate abstracts were prepared for two papers presented at this conference. Seventeen additional papers discuss various aspects of the lung clearance of inhaled aerosols and methods for the evaluation of air pollution effects in man and laboratory animals. (CH)

42128 **Lung clearance of particles.** Ferin, J. (Univ. of Rochester, NY). pp 64-78 of In Air pollution and the lung. Aharonson, E.F. (ed.). New York; John Wiley and Sons, Inc. (1976).

From 12. annual OHOLO biological conference; Ma'alot, Israel (16 Mar 1975).

See CONF-750384—.

It is generally agreed that lung clearance of particles is a very complex process, involving different mechanisms whereby the alveolar walls are kept clear from different inhaled or endogenous substances which otherwise could interfere with gas exchange. To observe and measure lung clearance, some test substance has to be used and for the most part is introduced into the respiratory system. The tracking of this substance and the subsequent different clearance patterns obtained under various experimental conditions is then the basis for retention and clearance assessments. It is obvious that, depending on the substance utilized and on the experimental regimen used, different clearance mechanisms may in fact be tested. In this report the main mechanisms involved in a titanic oxide (TiO_2) clearance model will be presented. This model was used as a functional test in rats in studies of selected air pollutants and experimental emphysema as a representative of low solubility nuisance particles.

42129 **Selection of animal models for evaluation of inhalation hazards in man.** Stuart, B.O. pp 268-288 of In Air pollution and the lung. Aharonson, E.F. (ed.). New York; John Wiley and Sons, Inc. (1976).

From 12. annual OHOLO biological conference; Ma'alot, Israel (16 Mar 1975).

See CONF-750384—.

To predict the hazards to man of inhaled dangerous materials, studies on effects should initially be performed involving species comparison among short-lived laboratory mammals (rodents). Confirmatory studies in long-lived species (primarily, the dog, but with increasing use of subhuman primates or miniature swine) should be conducted to verify metabolic pathways and long-term effects. In performing these experiments, animals should be exposed to graded doses of chemical or radiological pollutants and observed throughout their life-span in order to evaluate life-shortening and the incidence of late pulmonary and systemic organ effects. Quantitative evaluation of dose-response relationships must depend on reliable data based on tissue levels of a specific pollutant or its corresponding metabolites (dosimetry). This will require a detailed evaluation of

toxicant metabolism and retention kinetics. For both radionuclide and chemical air pollution studies, it will be necessary to identify important variables that will influence the nature and severity of the biological response. To reliably model the hazards of inhaled air pollutants to man, these variables must include the route of administration, dose protraction, age at time of exposure, species differences, and concurrent or prior contacts with other toxic agents. 190 references.

42130 Laboratory technique for obtaining fathead minnow eggs for use in toxicity experiments. Till, J.E. (Oak Ridge National Lab., TN). *Prog. Fish-Cult.;* **39**: No. 1, 24-27(Jan 1977).

A laboratory technique for collecting freshly fertilized eggs of the fathead minnow (Pimephales promelas) has been developed for use in toxicity testing of radioactive materials or other environmental pollutants. The fathead minnow egg was selected as a test organism because the period of embryogenesis is relatively short, the number of eggs per spawning is sufficiently large to provide a test group and a control group, and the size of the parent fish is compatible with laboratory facilities. Under a controlled laboratory environment, eggs are available all year. Nesting sites were constructed by cutting plastic pipe in half and covering the inside of the pipe with 1-mm-thick translucent polyethylene. The polyethylene with the eggs attached was removed from the shelter and cut into two pieces, each piece containing approximately the same number of eggs. One piece of polyethylene was floated in the test solution, and the other in spring water as a control. Hatching occurs in 168 h at 24°C. Toxicity of the test solution may be scored on the percentage of eggs hatching, the number of abnormal larvae produced, and larval survival.

MAN

REFER ALSO TO CITATION(S) 40862, 40990, 42043, 42123, 42127, 42127, 42129

42131 (NTIS/PS—76/964) **Environmental carcinogens (a bibliography with abstracts). Report for 1964—Nov 1976.** Crockett, P.W. (National Technical Information Service, Springfield, Va. (USA)). Dec 1976. 192p. NTIS, PC N01/MF A01.

Supersedes NTIS/PS—75/844 and NTIS/PS—74/086.

The bibliography cites research reports on the identification, sources, and toxicity of environmental carcinogens. Included are data on pesticides, fire extinguishing agents, environmental pollutants, food additives, and radiation. (This updated bibliography contains 187 abstracts, 29 of which are new entries to the previous edition.)

42132 Review of the carcinogenicities of nickel, chromium, and arsenic compounds in man and animals. Sunderman, F.W. Jr. (Univ. of Connecticut, Farmington). *Prev. Med.;* **5**: 279-294(1976).

Increased incidences of cancer of the respiratory tract have been reported among workers in nickel refineries; industrial workers who have been engaged in production of chromates or in processing of chrome pigments; and workers who have had diverse occupational exposures to arsenic compounds (metallurgical, chemical and agricultural workers). Human subjects who have developed clinical manifestations of arsenicalism as a result of environmental, occupational or iatrogenic exposures have been reported to have increased incidences of cancers of the skin and possibly of internal organs. Certain nickel and chromium compounds (e.g., nickel subsulfide and calcium chromate) that have been administered to rodents by parenteral or respiratory routes have induced cancers at the sites of deposition. Experimental induction of cancers in animals has not been reported as a consequence of administration of arsenic compounds.

42133 Hazards of cobalt. Payne, L.R. *J. Soc. Occup. Med.;* **27**: No. 1, 20-25(Jan 1977).

From Society of Occupational Medicine meeting; Birmingham, Eng. (18 Feb 1976).

Cobalt is used both in industry and in medicine. Industrially, it is used in various alloys—conferring properties of wear and corrosion resistance or enhanced magnetic permeability—as a catalyst, a pigment or a binder in the tungsten carbide industry. Medically, vitamin B_{12} requires cobalt while the radioactive isotope cobalt 60 is used in radiotherapy and gamma radiography. Dietary cobalt deficiency in animals is responsible for a serious wasting disease. Excess cobalt in both animals and man can produce polycythaemia, cardiomegaly or diffuse interstitial pulmonary fibrosis. Hypersensitivity is not uncommon. No confirmed association between cobalt and neoplasm has been fully established.

42134 Cautionary tale of a lead hazard in recycling of waste. Tyrer, F.H. *J. Soc. Occup. Med.;* **27**: No. 1, 26-30(Jan 1977).

Four cases of lead poisoning occurred during the first few months of operation of a plant designed to screen and bag grit derived from the slag of a lead smelting works. During the investigation the company voluntarily decided to discontinue the whole operation because of the evidence of a serious lead hazard which came to light. The investigations and results are described, and the lessons to be learned are discussed.

OTHER ENVIRONMENTAL POLLUTANT EFFECTS

42135 (AD-A—030874) **Radiofrequency radiation dosimetry handbook. Interim report 1 Jan—31 Jul 76.** Johnson, C.C.; Durney, C.H.; Barber, P.W.; Massoudi, H.; Allen, S.J. (Utah Univ., Salt Lake City (USA). Dept. of Bioengineering). Sep 1976. Contract F41609-76-C-0025. 127p. NTIS, PC A07/MF A01.

Considerable effort has been expended recently in biological experimentation and theoretical analysis of radiofrequency electromagnetic radiation effects on humans and experimental animals. An important part of this work is dosimetry, determining the amount of energy that is absorbed in the tissues. To provide the link between biological effects observed in irradiated animals and corresponding effects which might occur in man, theoretical methods are necessary to relate absorbed energy in man and animals to the incident radiation intensity. A handbook of data has been compiled to fill this need. (Author) (GRA)

42136 (AD-A—030896) **Hearing conservation program prototype phase final report. Technical report.** Lehr, J.; Nelson, D.; Sutterlin, M. (Bolt, Beranek and Newman, Inc., Arlington, Va. (USA)). Sep 1976. Contract N00014-75-C-0057. 163p. (BBN—3222). NTIS, PC A08/MF A01.

This report covers the prototype phase of an OPNAV sponsored hearing conservation program. The objective of the prototype phase was to demonstrate the feasibility of reducing machinery space noise levels sufficiently to comply with BUMED/OSHA hearing damage risk criteria. The USS ELMER MONTGOMERY (FF 1082), the designated prototype ship, was subjected to comprehensive underway and dockside diagnostic noise testing. The tests indicated that even at nominal 15 to 20 knot cruising speeds, noise levels at many manned locations in the engine room and fire room exceeded the BUMED 90 dBA hearing damage risk criterion. Conceptual approaches for noise control treatment were provided to the naval shipyard which developed the design for the prototype treatments. Subsequent noise trials conducted to assess the performance of the prototype treatments indicated the predicted noise reduction from the treatments was achieved. Noise trials were also conducted on a second ship in the class, the USS DOWNES (FF 1070), to insure that differences in equipment manufacture or shipyard construction practices did not result in significant differences in the noise environment within the FF 1052 class machinery spaces. The report concludes with a recommended noise control package for ships of the FF 1052 class.

42137 (NTIS/PS—77/0028) **Biological effects of laser radiation (a bibliography with abstracts). Report for 1964—Jan 1977.** Crockett, P.W. (National Technical Information Service, Springfield, Va. (USA)). Feb 1977. 216p. NTIS, PC N01/MF A01.

Supersedes NTIS/PS—75/893 and NTIS/PS—75/011.

The bibliography cites reports on radiation injuries to plants and animals, permissible dosage, protective devices, and safety measures. Included are references on the pathology of eye lesions caused by lasers. (This updated bibliography contains 211 abstracts, 23 of which are new entries to the previous edition.)

HEALTH AND SAFETY

42138 (PB—255197) **Generic environmental statement on routine use of plutonium-powered cardiac pacemakers. Final report.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Nuclear Material Safety and Safeguards). Jul 1976. 285p. (NUREG—0060). NTIS $9.25.

Supersedes TID—26718.

The statement concludes that based on the balancing of the benefits and risks involved, plutonium powered-pacemakers can be licensed for routine use. Previously, the Commission licensed plutonium-powered cardiac pacemakers on a limited, investigational basis. Also included are the comments of Federal, State, and local governmental agencies, certain non-government organizations and of private individuals on the Draft Generic Environmental Statement results of a questionnaire to physicians regarding the need for nuclear pacemakers and the staff responses to those comments. (GRA)

GEOSCIENCES

GEOLOGY AND HYDROLOGY

REFER ALSO TO CITATION(S) 40864, 40866, 40895, 40937, 41594

42139 (PB—258102) **Heat and mass transfer in porous rock fragments.** Kuo, M.T.; Kruger, P.; Brigham, W.E. (Stanford Univ., Calif. (USA). Stanford Geothermal Program). Dec 1975. Contract NSF-AER72-03490. 103p. (SGP-TR—10). NTIS, PC A06/MF A01.

Fracture stimulation is expected to increase the productivity of geothermal reservoirs by providing increased permeability in hydrothermal systems or increased surface area for heat transfer in hot igneous systems. The extent of heat and mass transfer from porous rock fragments to circulating fluids is important for evaluating the effects of fracture stimulation. Experimental data have been obtained for individual spherical porous rocks. The rate of mass transfer between tritiated-water saturated rock to surrounding fluid was determined by radioactivity measurement. The rate of heat transfer was determined by quartz thermometry. The measured effective mass diffusivity of the micropore water was of the order of .000001 square centimeters/sec and the measured thermal diffusivity of the rock fragments was of the order of .01 square centimeters/sec. These data were used to analyze energy transfer for a model involving both intrasphere and interface transport steps. The results show that heat transfer is the dominant mechanism for transferring energy from hot porous spheres to circulating cold water at constant pressure. (GRA)

42140 (UCRL—52238) **Geophysical and geochemical models of the Earth's shields and rift zones.** Chung, D.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Feb 1977. Contract W-7405-ENG-48. 14p. Dep. NTIS, PC A02/MF A01.

This report summarizes a collection of, synthesis of, and speculation on the geophysical and geochemical models of the earth's stable shields and rift zones. Two basic crustal types, continental and oceanic, and two basic mantle types, stable and unstable, are described. It is pointed out that both the crust and upper mantle play a strongly interactive role with surface geological phenomena ranging from the occurrence of mountains, ocean trenches, oceanic and continental rifts to geographic distributions of earthquakes, faults, and volcanoes. On the composition of the mantle, there is little doubt regarding the view that olivine constitutes a major fraction of the mineralogy of the earth's upper mantle. Studies are suggested to simulate the elasticity and composition of the earth's lower crust and upper mantle.

GEOPHYSICS

REFER ALSO TO CITATION(S) 40925, 40937

SEISMOLOGY AND TECTONICS

42141 (RLO—2229-TC-3) **Alaska Peninsula telemetered seismic network. Annual report.** Pulpan, H. (Alaska Univ., College (USA). Geophysical Inst.). Jun 1976. Contract EY-76-S-06-2229. 15p. Dep. NTIS, PC A02/MF A01.

A network of ten short-period seismograph stations has been installed in the area of the Alaska Peninsula between Port Heiden and King Salmon. Nine of the stations are at remote locations, the seismic signals being transmitted via VHF radio links and telephone lines to a common recording site.

GEOPHYSICAL SURVEY METHODS

REFER ALSO TO CITATION(S) 40918, 40927

42142 (E—76-10420) **Summary of space imagery studies in Utah and Nevada.** Jensen, L.M. (Utah Univ., Salt Lake City (USA)). 1975. Contract NAS9-13322. 45p. NTIS $4.00.

The author has identified the following significant results. An enhanced enlargement of a S190B color image at a scale of 1/19,200 of the Bingham porphyry copper deposit has compared a geological map of the area with the space imagery map as fair for the intrusion boundaries and total lack of quality for mapping the sediments. Hydrothermal alteration is only slightly evident on space imagery at Bingham, but in the Tintic mining district and the volcanic piles of the Keg and Thomas ranges, Utah, hydrothermal alteration is readily mapped on color enlargements of S190B. Several sites of calderas were recognized and new ones located on space imagery. One of the tools developed is a mercury soil-gas analyzer that is becoming significant as an aid in locating hidden mineralized zones which were suggested from space imagery. In addition, this tool is a prime aid in locating and better delineating geothermal sites. (GRA)

42143 **Comparison of sounding results and their interpretation in the absence of borehole control.** Habberjam, G.M. (Univ of Leeds, Engl). *Geoexploration;* **14**: No. 3-4, 215-228(Oct 1976).

Resistivity sounding curves are first examined as a site characteristic and the 'associa'ion parameter' defined as an objective assessment of site differences. Magnitudes of this parameter are examined and its use to investigate structure indicated. Resistivity curves as profiles of four electrode resistivity space are then considered, with the problems of sounding interval and orientation dependence, in constructing resistivity space sections. The use of such sections for indicating favorable sites for depth interpretation is stressed. Full spatial solutions for the square array have also been derived for the outcropping vertical dyke problem. Observed spaces seldom correspond to such simple models, but regions of the observed space may frequently correspond to them. 6 refs.

42144 **Application of electromagnetic frequency sounding to groundwater problems.** Koefoed, O.; Biewinga, D.T. (Delft Univ of Technol, Neth). *Geoexploration;* **14**: No. 3-4, 229-241(Oct 1976).

The electromagnetic frequency sounding method has been used for the last ten years, particularly in eastern Europe, mainly for the purpose of very deep investigations. As might be expected, however, the method also offers certain advantages when applied to groundwater investigations. The first advantage of the electromagnetic sounding method is that depth penetration of the current can be changed by changing the frequency, which is far more convenient than displacing the current electrodes as is done in resistivity sounding. The second advantage of the electromagnetic sounding method applies in particular in arid areas where the highly resistive surface layer causes difficulties in introducing the current into the ground by means of conductive contact; this difficulty is entirely avoided when the electromagnetic method is used. To try out the utility of the electromagnetic frequency sounding method in the conditions described above, a suitable instrument was built, interpretation theory developed, and experimental surveys carried out in two arid areas in South Tunisia.

GEOCHEMISTRY

42145 (N—76-27750) **Iodine in oil and gas fields: especially on the geochemical consideration of the prospecting for iodine deposits.** Motojima, K. Translated from *Chishitsu Chosasho Geppo;* **22**: No. 10, 25-40(Jul 1976). 38p. (NASA-TT-F—17104). NTIS $4.00.

Iodine contents in brines of gas and oil fields throughout the world are surveyed from the standpoint of water quality and Cl content, and brines from oil, gas, and coal fields in Japan are studied in terms of Cl content. The distribution of iodine and halogens and their relationship in underground waters and the relationship between iodine and organic substances are discussed. Conclusions pertaining to geochemical prospecting are presented. (Author) (GRA)

OCEANOGRAPHY

42146 (RLO—2225-T25-18) **Physical oceanography and sediment transport on the Washington continental shelf. Report of progress, October 1975—September 1976.** Smith, J.D.; Hickey, B. (comps.). (Washington Univ., Seattle (USA). Dept. of Oceanography). 30 Jun 1976. Contract EY-76-S-06-2225. 62p. Dep. NTIS, PC A04/MF A01.

Results are reported from studies on large-scale coastal circulation, studies in the benthic boundary layer and an analysis of coastal tidal currents of the Washington continental shelf of the Pacific Ocean. The similarity of currents from Vancouver Island to mid-Oregon was established.

42147 (SRO—890-2) **Trace element geochemistry of the South Atlantic Bight. Progress report, June 1, 1976—May 31, 1977.** Windom, H.L. (Skidaway Inst. of Oceanography, Savannah, Ga. (USA)). 1 Mar 1977. Contract EY-76-S-09-0890. 105p. Dep. NTIS, PC A06/MF A01.

Ten major rivers of the southeastern United States have been sampled monthly over a year period for copper and for six months for nickel and zinc. One year's data has also been obtained for mercury and arsenic. The locations of the Atlantic Ocean continental shelf surface water samples collected during the past year are shown. During the same cruises atmospheric samples were also collected. The data indicate that: the most important input mechanism for trace elements to the continental shelf is intrusions with the possible exception of mercury which has an equally important input via the atmosphere; the residence times of all the trace elements studied in continental shelf waters are similar (about 0.26 yr) but different from that of water (0.37 yr); a portion of trace elements transported to the shelf by rivers may be lost by incorporation onto particles that are swept off the shelf or deposited on the bottom; and

trace elements are apparently regenerated at depth in the Gulf Stream and off shelter waters, and increased levels may be correlated with nutrient concentrations. A list is included of published papers that report the results in detail.

PHYSICS RESEARCH

ASTROPHYSICS AND COSMOLOGY

COSMIC RADIATION

REFER ALSO TO CITATION(S) 41928, 41929, 42164

42148 (AD-A—028978) **Summary of cutoff rigidities calculated with the International Geomagnetic Reference Field for various epochs. Environmental research papers.** Shea, M.A.; Smart, D.F.; Carmichael, H. (Air Force Geophysics Lab., Hanscom AFB, Mass. (USA)). 26 May 1976. 98p. (AFGL-TR—76-0115;AFGL-ERP—561). NTIS $5.00.

Tables of cosmic-ray cutoff rigidities using the trajectory-tracing technique are given for five Epochs of the geomagnetic field. These values have been determined utilizing the International Geomagnetic Reference Field with time derivatives applied so that the coefficients for the field model are appropriate for the following Epochs: 1955.0, 1965.0, 1966.5, 1970.0, and 1975.0. Each table includes the geographic coordinates and L value of each location together with the main cutoff rigidity, the Stormer cutoff rigidity, and the effective cutoff rigidity. Tables for both vertical and non-vertical directions are included, as well as a listing of the FORTRAN computer program used to calculate these values. (auth)

42149 (N—76-28148) **Reanalysis of the Apollo cosmic gamma-ray spectrum in the 0.3 to 10 MeV energy region.** Trombka, J.I.; Dyer, C.S.; Evans, L.G.; Bielefeld, M.J.; Seltzer, S.M. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Jun 1976. Contract NAS7-100. 36p. (NASA-TM-X—71150; X—682-76-128). NTIS $4.00.

No abstract available. (GRA)

42150 (N—76-31119) **Mass fractionation of the lunar surface by solar wind sputtering.** Switkowski, Z.E.; Haff, P.K.; Tombrello, T.A.; Burnett, D.S. (California Inst. of Tech., Pasadena (USA)). 1975. Contracts NGR-05-002-333;NSF PHY-76-02724. 32p. (NASA-CR—148779). NTIS $4.00.

The sputtering of the lunar surface by the solar wind is examined as a possible mechanism of mass fractionation. Simple arguments based on current theories of sputtering and the ballistics of the sputtered atoms suggest that most ejected atoms will have sufficiently high energy to escape lunar gravity. However, the fraction of atoms which falls back to the surface is enriched in the heavier atomic components relative to the lighter ones. This material is incorporated into the heavily radiation-damaged outer surfaces of grains where it is subject to resputtering. Over the course of several hundred years an equilibrium surface layer, enriched in heavier atoms, is found to form. The dependence of the calculated results upon the sputtering rate and on the details of the energy spectrum of sputtered particles is investigated. It is concluded that mass fractionation by solar wind sputtering is likely to be an important phenomenon on the lunar surface. (auth)

42151 (N—76-29148) **Measurement of hard cosmic rays in September 1973 by Mars-4, Mars-5 and Mars-7.** Gorchakov, Y.V.; Ignatev, V.A.; Iozenas, V.A.; Shvidkovskaya, T.E.; Yakovlev, V.A. Translated from *Kosm. Issled.;* **14**: No. 1, 65-72(1976). 17p. (NASA-TT-F—15488). NTIS $3.50.

Instrument characteristics and the results of intensity measurements of protons, alpha- particles and nuclei with $Z = \text{or} < 15$ are presented. The measurements were performed by the STS-5 gas-discharge counters ($Ep < 30$ MeV) and Cherenkov counters ($Ep < 500$ MeV/nucleon). The flare initiated on September 7 in a model of spherically symmetrical diffusion leads to the relationship of the diffusion coefficient and the distance. (auth) (GRA)

STARS

42152 (N—76-27134) **The relativistic equations of stellar structure and evolution. stars with degenerate neutron cores. I. Structure of equilibrium models.** Thorne, K.S.; Zytkow, A.N. (California Inst. of Tech., Pasadena (USA). W.K. Kellogg Radiation Lab.). May 1976. Contracts NGR-05-002-256;NSF-AST75-01398-A01. 72p. (NASA-CR—148213;OAP—453). NTIS $4.50.

The general relativistic equations of stellar structure and evolution are reformulated in a notation which makes easy contact with Newtonian theory. Also, a general relativistic version of the mixing-length formalism for convection is presented. Finally, it is argued that in previous work on spherical systems general relativity theorists have identified the wrong quantity as total mass—energy inside radius r. (auth)

42153 (N—76-28125) **Photometric study of the Orion OB 1 association. 1. Observational data.** Warren, W.H. Jr; Hesser, J.E. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Jun 1976. 161p. (NASA-TM-X—71151). NTIS $6.75.

Subm-Submitted for Publication.

An extensive catalog of observational data is presented for stars in the region of the young stellar association Orion OB 1. In addition to new photoelectric observations obtained on the uvbyB and UBV systems, photoelectric and spectroscopic data were compiled for the stars observed and for several bright members of the association having available photometric indices. Mean weighted values were computed for the uvbyB and UBV data and are tabulated in summary tables which include all references for individual values. These tables are expected to be reasonably complete for association members earlier than spectral type A0. From an analysis of currently available proper motion, radial velocity, and photometric data, membership criteria were derived and qualitative membership probabilities for 526 stars were summarized. A set of charts is included for assistance in identification of the program stars in all regions of the association. (auth)

42154 (N—76-29084) **Hot interstellar tunnels. 1. Simulation of interacting supernova remnants.** Smith, B.W. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). May 1976. Contract NGL-50-002-044. 66p. (NASA-TM-X—71148; X—661-76-119). NTIS $5.00.

Misc-Revised. Subm-Prepared in Cooperation with Wisconsin Univ.

The theory required to build a numerical simulation of interacting supernova remnants is developed. The hot cavities within a population of remnants will become connected, with varying ease and speed, for a variety of assumed conditions in the outer shells of old remnants. Apparently neither radiative cooling nor thermal conduction in a large-scale galactic magnetic field can destroy hot cavity regions, if they grow, faster than they are reheated by supernova shock waves, but interstellar mass motions disrupt the contiguity of extensive cavities necessary for the dispersal of these shocks over a wide volume. Monte Carlo simulations show that a quasi-equilibrium is reached in the test space within 10 million years of the first supernova, and is characterized by an average cavity filling fraction of the interstellar volume. Aspects of this equilibrium are discussed for a range of supernova rates. Two predictions are not confirmed within this range: critical growth of hot regions to encompass the entire medium, and the efficient quenching of the expansion of a remnant by interaction with other cavities. (auth)

42155 (N—76-29099) **Line identifications in the ultraviolet spectra of tau Herculis, B5 IV, and zeta Draconis, B6 III.** Underhill, A.B.; Adelman, S.J. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Aug 1976. 125p. (NASA-TM-X—71167; X—670-76-173). NTIS, PC A06/MF A01.

Subm-Submitted for Publication.

Tables of the lines found on two tracings each of the ultraviolet spectrum of tau Her, B5 IV, and zeta Dra, B6 III, made by the Copernicus satellite and possible identifications are given. The ranges 1025—1451A for tau Her and 1035 to 1425A for zeta Dra are covered by the U2 spectrometer at a resolution of 0.2A; the ranges 2028 to 2959A for tau Her and 2000 to 3000A for Dra are covered by the V2 spectrometer at a resolution of 0.4A. The observed density of lines in the U2 region is 1.1 lines/A for tau Her and 1.7 lines/A for zeta Dra. In the V2 region it is 0.8 lines/A for tau Her and 0.9 lines/A for zeta Dra. (auth)

42156 (N—76-30126) **Orbital changes of the gaseous ring around B/sub e/ stars.** Huang, S.S. (Northwestern Univ., Evanston, Ill. (USA). Dept. of Astronomy). 1976. Contract NGL-14-007-041. 26p. (NASA-CR—148563). NTIS $4.00.

In order to understand the seemingly erratic V/R variations and radial velocity curves of emission edges and central absorption of some Be stars, a theory is advanced to explain the changes of structure of the gaseous ring around these stars. The theory is based on the interaction between the existing ring and the newly ejected matter from the star. It shows that the structural change of the ring is completely controlled by the angular momentum input factor and the dissipation factor. In light of this understanding, the observed results of β Mon and π Aqr. are interpreted. (auth)

QUASI-STELLAR, RADIO, AND X-RAY SOURCES

42157 (N—76-27135) **X-ray emission from the supernova remnant G287.8-0.5.** Becker, R.H.; Boldt, E.A.; Holt, S.S.; Pravdo, S.H.; Rothschild, R.E. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Jun 1976.

Contract NGR-21-002-316. 10p. (NASA-TM-X—71131;X—661-76-113). NTIS, PC A03/MF A01.

The GSFC Cosmic x-ray spectroscopy experiment on OSO-8 observed a weak galactic x-ray source near theta 2 at 288 deg, b2 at -1 deg. The spectrum for this source between 2—20 keV is well represented by a thermal spectrum of kT = 7.34/sup +3.6//sub -2.6/ keV with an intense iron emission line centered at 6.5 +- .2 keV. The error box of the Uhuru source 4U1043-59, the only known x-ray source in the field of view, contains the radio supernova remnant G287.8-0.5. The possible association of the x-ray source with this supernova remnant is discussed. (auth)

42158 (N—76-28120) **All-Sky Monitor observations of the decay of A0620-00 (Nova Monocerotis 1975).** Kaluzienski, L.J.; Holt, S.S.; Boldt, E.A.; Serlemitsos, P.J. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Jul 1976. 27p. (NASA-TM-X—71139; X—661-76-142). NTIS, PC A03/MF A01.

Subm-Submitted for Publication.

The All-Sky X-ray Monitor onboard Ariel 5 has observed the 3—6 keV decline of the bright transient x-ray source A0620-00 on a virtually continuous basis during the period September 1975—March 1976. The source behavior on timescales of 100 minutes is characterized by smooth, exponential decays interrupted by substantial increases in October and February. The latter increase was an order-of-magnitude rise above the extrapolated exponential fall-off, and was followed by a final rapid decline. Upper limits of 2.5% and 10% were found for any periodicities in the range 20d—10d during the early and later decay phases, respectively. A probable correlation between the optical and 3-6 keV emission from A0620-00 was noted, effectively ruling out models involving traditional optical novae in favor of Roche-lobe overflow in a binary system. The existing data on the transient x-ray sources is consistent with two distinct luminosity—lifetime classes of these objects. (auth)

42159 (N—76-28123) **HEAO Block 2 study executive summary.** (National Aeronautics and Space Administration, Huntsville, Ala. (USA). George C. Marshall Space Flight Center). Mar 1976. 41p. (NASA-TM-X—73318). NTIS $4.00.

An executive summary is presented of a preliminary study done on several potential High Energy Astronomy Observatory (HEAO) missions which are follow-on missions to the currently defined HEAO program. The purpose was to examine several typical missions and determine the relative complexities associated with them. The four payloads investigated were a 1.2 m Diameter x-ray Telescope observatory, a Large Area Moderate Angular Resolution (LAMAR) observatory, a cosmic ray observatory, and (4) a gamma ray observatory. Each of the four observatories was considered a national facility. Low cost approaches were stressed throughout, with considerable use of HEAO Block I experience and designs effected to provide a high degree of confidence that such approaches were achievable. The use of the Multi-Mission Spacecraft (MMS) and the HEAO Block I spacecraft was considered as a result of this low cost emphasis. Also, NASA standard components were considered, where applicable. (auth)

42160 (N—76-31109) **The 35-d x-ray profile of Her X-1.** Holt, S.S.; Boldt, E.A.; Kaluzienski, L.J.; Serlemitsos, P.J.; Swank, J.H. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Aug 1976. 8p. (NASA-TM-X—71174; X—661-76-182). NTIS $3.50.

Subm-Submitted for Publication.

Substantial x-ray emission as reported by Ariel 5 from Her X-1 midway through the extended low-state portion of its 35-day cycle is examined. A similar feature during another cycle measured from UHURU satellite is also examined. It is proposed that this feature should occur regularly, consistent with some models for the mass accretion disc which have been reported in the literature. The results of the analysis of 500 days of Ariel-5 All-Sky Monitor data are reported which support the view that the feature occurs regularly in the 35-day cycle. (auth)

42161 (N—76-29149) **Powerful bursts of cosmic gamma radiation.** Prilutskiy, O.F.; Rozental, I.L.; Usov, V.V. Translated from *Usp. Fiz. Nauk;* **116**: No. 3, 517-538(Jul 1975). 43p. (NASA-TT-F—16733). NTIS $4.00.

Observations were made and theoretical models were suggested for bursts of cosmic gamma radiation. The identification of x-ray sources is also discussed. (auth)

42162 (N—76-25116) **Powerful galactic masers.** Burdyuzha, V.V.; Varshalovich, D.A.; Ruzmaykina, T.V. (AN SSSR, Moscow. Inst. Kosmicheskikh Issledovanij). Jun 1976. Translation of PR—246. (NASA-TT-F—17056). 27p. NTIS $4.00.

A study is made of certain problems of the astrophysics of galactic masers: pumping mechanisms, the nature of master condensation and polarization properties.

SOLAR PHENOMENA

REFER ALSO TO CITATION(S) 42150

42163 (N—76-27149) **Observations of limb flares with a soft x-ray telescope.** Gibson, E.G. (Aerospace Corp., El Segundo, Calif. (USA). Space Sciences Lab.). 16 Feb 1976. Contract NAS8-29602. 69p. (NASA-CR—144329;ATR—76(7405)-2). NTIS, PC A04/MF A01.

The structure and evolution of 26 limb flares have been observed with a soft-x-ray telescope flown on Skylab. The results are as follows: (1) one or more well defined loops were the only structures of flare intensity observed during the rise phase and near flare maximum, except for knots which were close to the resolution of the telescope; (2) the flare core features were always sharply defined during rise phase; and (3) for the twenty events which contained loops, the geometry of the structure near maximum was that of a loop in ten cases, a loop with a spike at the top in four cases, a cusp or triangle in four cases, and a cusp combined with a spike in another two cases. On the basis of observation of the original film, it is suggested that flares which underwent large scale deformations had become unstable to MHD kinks. This instability implies that these flares occurred in magnetic flux tubes through which significant currents were flowing.

42164 (N—76-27304) **Multi-satellite attitude prediction program/Orbiting Solar Observatory-8 (MSAP/OSO-8) operating guide.** Tate, V.H.; Wyckoff, D.C.; Decicco, J.M. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Mar 1976. Contract NAS5-11999. 154p. (NASA-TM-X—71158; X—582-76-153). NTIS $6.75.

The sun's lower corona and chromosphere and their interaction in the x-ray and ultraviolet (μv) spectral regions were investigated to understand better the transport of energy from the photosphere to the corona. The interaction between the solar electromagnetic and particle radiation and the earth's environment was studied, and the background component of cosmic x-rays was discussed. (auth)

42165 (N—76-28742) **Study of the relationship between solar activity and terrestrial weather.** Sturrock, P.A.; Brueckner, G.E.; Dickinson, R.E.; Fukuta, N.; Lanzerotti, L.J. (Stanford Univ., Calif. (USA). Inst. for Plasma Research). Aug 1976. Contract NGL-05-020-272. 28p. (NASA-CR—148541; SU-IPR—671). NTIS $4.00.

Evidence for some connection between weather and solar related phenomena is presented. Historical data of world wide temperature variations with relationship to change in solar luminosity are examined. Several test methods for estimating the statistical significance of such phenomena are discussed in detail. (GRA)

42166 (N—76-29361) **Extreme solar ultraviolet monitor (ESUM) for atmosphere Explorer.** (Ball Bros. Research Corp., Boulder, Colo. (USA)). 1 Apr 1976. Contract NAS5-11441. 59p. (NASA-CR—144766; F76—10). NTIS $4.50.

The design, operation, and calibration of both ESUM-C and ESUM-E are discussed along with objectives, system design, and function. (auth)

42167 (N—76-29863) **Synoptic approach to sun—weather investigations.** Wilcox, J.M. (Stanford Univ., Calif. (USA). Inst. for Plasma Research). May 1976. Contracts NGR-05-020-559;N00014-76-C-0207. 19p. (NASA-CR—148568;SU-IPR—663). NTIS $3.50.

The advantages of a regular program of daily observations of the magnetosphere, ionosphere and atmosphere are described. Such synoptic observations may be one of the best routes to understanding the physical mechanisms involved in sun-weather influences. Some specific examples of such observations are given. (auth)

42168 (N—76-30257) **Rutgers zodiacal light experiment on OSO-6. Final report.** Carroll, B. (Rutgers--the State Univ., New Brunswick, N.J. (USA)). 10 Dec 1975. Contract NAS5-9276. 92p. (NASA-CR—144798). NTIS, PC A05/MF A01.

A detector was placed in a slowly spinning wheel on OSO-6 whose axis was perpendicular to the line drawn to the sun, to measure the surface brightness and polarization at all elongations from the immediate neighborhood of the sun to the anti-solar point. Different wavelength settings and polarizations were calculated from the known order of magnitude brightness of the zodiacal light. The measuring sequence was arranged to give longer integration times for the regions of lower surface brightness. Three types of analysis to which the data on OSO-6 were subjected are outlined; (1) photometry, (2) colorimetry and (3) polarimetry. (GRA)

42169 (N—76-31126) **Measures of the solar spectral irradiance between 1200 and 3000 a.** Heath, D.F.; Thekaekara, M.P. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Jul 1976. 37p. (NASA-TM-X—71172; X—912-76-171). NTIS $4.00.

Subm-Submitted for Publication.

Tabulated data on solar flux measurements are presented. The measurements, taken from balloons, rockets and satellites, are not

new data, but have been critically re-evaluated. The eleven year sunspot cycle is discussed. Also discussed is the brightness temperature. The effect of solar radiation at various wavelengths on the photochemistry of stratospheric ozone is briefly discussed. (GRA)

42170 (PB—263007) **Solar—geophysical data number 387. Part II. Comprehensive reports. Data for May 1976—April 1976 and miscellanea. Explanation of data reports issued as number 378 (supplement) February 1976.** Leighton, H.I. (National Geophysical and Solar-Terrestrial Data Center, Boulder, Colo. (USA)). Nov 1976. 42p. (SGD—387-Pt-2). NTIS, PC A03/MF A01.

See also PB—261462 and PB—263008.

This comprehensive report for May 1976, April 1976 and Miscellanea provides data on solar flares, solar radio waves, energetic solar particles, abbreviated calendar record, regional flare index, solar radio waves spectral observations, and solar wind.

42171 (PB—263008) **Solar—geophysical data number 387. Part I. Prompt reports. Data for October 1976—September 1976. Explanation of data reports issued as number 378 (supplement) February 1976.** Leighton, H.I. (National Geophysical and Solar-Terrestrial Data Center, Boulder, Colo. (USA)). Nov 1976. 121p. (SGD—387-Pt-1). NTIS, PC A06/MF A01.

See also rept. PB—261461 and PB—263007.

This prompt reports provides October 1976 and September 1976 data on: alert periods, daily solar indices, solar flares, solar radio waves, solar wind measurements, spacecraft observations, solar X-ray radiation, coronal holes, inferred IP magnetic field polarities for October. It also provides data on daily solar activity center, sudden ionospheric disturbances, solar radio waves, cosmic rays, geomagnetic indices and radio propagation indices.

42172 (N—76-28122) **Optical observations from the Voskhod-2 spacecraft.** Lazarev, A.I.; Khrunov, Y.V. 30 Jun 1976. Translation of Opticheskiye Nablyudeniya S Kosmicheskogo Korablya Voskhod-2. (NASA-TT-F—17074). 52p. NTIS $4.50.

Based on visual observations and photography by Soviet and American astronauts, as well as on color pictures painted aboard Voskhod-2, the solar corona, Fresnel reflection of the sun from the atmosphere of the earth and from comet Kohoutek, and noctilucent clouds on the night side of the earth are discussed and analyzed. The possibilities of the study of Fresnel reflection of the sun from the atmosphere of Venus and of observation of Fresnel reflections of the stars and planets from the nighttime atmosphere of the earth are discussed. (auth)

PLANETARY PHENOMENA

42173 (N—76-25115) **Cosmogenic radionuclides in stone meteorites.** Cressy, P.J. Jr. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). May 1976. 31p. (NASA-TN-D—8241; G—7658). NTIS $4.00.

This document presents the techniques and compilation of results of cosmogenic ^{26}Al measurements at Goddard Space Flight Center on 91 samples of 76 stone meteorites. Short-lived radionuclides, including ^{22}Na, ^{46}Sc, ^{54}Mn, and Co-60, were measured in 13 of these meteorites. About one-third of these data have not previously been published. The results are discussed briefly in terms of depletion of ^{26}Al and natural potassium due to weathering; possible exposure of several chondrites to an unusually high cosmic-ray flux; comparison of ^{26}Al, ^{22}Na, ^{46}Sc, and $^{54}M_{17}$ in chondrites with the spallation $^{22}Ne/^{21}Ne$ ratio as a shielding indicator; and comparison of ^{26}Al—$^{22}Ne/^{21}Ne$ data for achondrite classes with the chondrite trend.

42174 (N—76-31115) **Interplanetary boundary layers at 1 AU.** Burlaga, L.F.; Lemaire, J.F.; Turner, J.M. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Jul 1976. 40p. (NASA-TM-X—71171;X—692-76-168). NTIS, PC A03/MF A01.

The structure and nature of discontinuities in the interplanetary magnetic field at 1 AU in the period March 18, 1971, to April 9, 1971, is determined by using high-resolution magnetic field measurements from Explorer 34. The discontinuities that were selected for this analysis occurred under a variety of interplanetary conditions at an average rate of 0.5/h. This set does not include all discontinuities that were present, but the sample is large and it is probably representative. Both tangential and rotational discontinuities were identified, the ratio of TD's to RD's being approximately 3 to 1. Tangential discontinuities were observed every day, even among Alfvenic fluctuations. The structure of most of the boundary layers was simple and ordered, i.e., the magnetic field usually changed smoothly and monotonically from one side of the boundary layer to the other. (auth)

ATMOSPHERIC PHYSICS

AURORAL AND IONOSPHERIC PHENOMENA

REFER ALSO TO CITATION(S) 42171, 42254

42175 (AD-A—027041) **Model of equatorial scintillations from in situ measurements. Environmental research papers.** Basu, S.; Basu, S.; Khan, B.K. (Air Force Geophysics Lab., Hanscom AFB, Mass. (USA)). 13 Apr 1976. 31p. (AFGL-TR—76-0080; AFGL-ERP—555). NTIS $4.00.

Measurements of F-region irregularity amplitude and ambient electron density made in situ by the retarding potential analyzer (RPA) on OGO-6 near perigee altitude of 400 km have been utilized to derive the variation of electron density deviation over the equatorial region. Based on these measured electron density deviations and other assumed model parameters, including a three-dimensional power-law form of irregularity spectrum of index 4, a model of equatorial scintillations is developed in the framework of diffraction theory. The percentage occurrence contours of estimated equatorial scintillations greater than or equal to 4.5 dB at 140 MHz during 1900 to 2300 LMT for the period November to December 1969 and 1970 have been derived. The model is found to depict a pronounced longitude variation with the scintillation belt width and percentage occurrence being maximum over the African sector. The latitude extent of the spatial scintillation belt narrows over the American sector without much decrease in the scintillation occurrence, whereas over the Indian and Far Eastern sectors both the extent and the occurrence are found to decrease. The percentage occurrence of scintillations estimated from this model is found to be consistent with vhf scintillation measurements at Ghana, Huancayo, and Calcutta. In addition, the model was found to be in qualitative agreement with GHz observations at various longitudes made by the COMSAT group. The effect of varying model parameters on scintillation estimates at vhf, uhf and GHz are discussed. Implications of the observed longitudinal variation of scintillations on current theories of equatorial irregularity formation are indicated.

42176 (AD-A—030739) **ATS-6 40- and 360-MHz differential phase measurements. Environmental research papers.** Slack, F.F. (Air Force Geophysics Lab., Hanscom AFB, Mass. (USA)). 2 Jun 1976. 32p. (AFGL-TR—76-0119; AFGL-ERP—564). NTIS $4.00.

Equipment employing new cross-correlation design concepts for receiving and processing weak rf signals in a noisy environment is described. It is shown how this equipment becomes an integral part of the instrumentation for measuring the differential phase between the ATS-6 satellite 40- and 360-MHz coherent cw signals that have been propagated through the ionosphere. The relationship between 40-MHz phase and amplitude scintillation was developed using differential phase data from the ATS-6 geostationary satellite. The 40- and 360-MHz coherent signals were propagated through the ionosphere and received on the 150-ft radio telescope at the Sagamore Hill Radio Observatory. The influence that the traveling ionospheric disturbances (TID) have on the phase of the 40-MHz signal receives special emphasis, and it is shown how the presence of TID aids in the analysis. (GRA)

42177 (AD-A—030741) **Improving the global ionospheric predictions of f(o)F2. Air force surveys in geophysics.** Dandekar, B.S. (Air Force Geophysics Lab., Hanscom AFB, Mass. (USA)). 10 Jun 1976. 26p. (AFGL-TR—76-0124; AFGL-AFSG—344). NTIS $4.00.

By use of the method of Rush and Gibbs (1973), weighted means of observed values have been used to update the global prediction of f(o)F2, which are based on monthly median values derived from the Institute of Telecommunications Sciences model (1969). This procedure improved the predictions for magnetically quiet periods, for times near minimum of the solar cycle phase, and for the equinoctial months. Furthermore, a closer grid of ionosonde stations resulted in reducing the error in the f(o)F2 prediction. For the method of Rush and Gibbs (1973) to be operationally successful in global predictions of f(o)F2, however, a closer grid of ionosondes than is presently available is needed. (auth)

42178 (AD-A—034381) **Report on the geophysical description and available data associated with rocket PF-SH-92 (IC 519.07-1B).** Romick, G.J. (Alaska Univ., College (USA). Geophysical Inst.). Jan 1976. Contract F19628-74-C-0188. 47p. NTIS, PC A03/MF A01.

Report on High Altitude Effects Simulation Program. See also report dated May 1975, AD-A—018055.

This report covers technical activities performed during the period November 1975 through January 1976. It provides a geophysical description of the auroral and geomagnetic environment during the launch of ICECAP rocket PF-SH-92 (IC 519.07-18). An interpretation of the primary measurements obtained by the sensors onboard this specific experimental payload is included.

42179 (AD-A—034490) **Study and analysis of total electron content and scintillation data. Report for 1 Jul 1975-30 Jun 1976.** Basu,

S.; Cantor, C.J.; Johanson, J.; MacKenzie, E.; Hagan, M.P. (Emmanuel Coll., Boston, Mass. (USA)). Oct 1976. Contract F19628-76-C-0003. vp.

This report embodies a study of ionospheric scintillations as considered from the following aspects: 1) Overall view of scintillations using a large data base, and also the detailed, individual magnetic storm picture. Solar flux level, seasonal variation, invariant latitude, and irregularity region are discussed. 2) Total Electron Content measurements through Faraday rotation and group delay methods. Results of employment of these techniques are discussed. The M-factor, for conversion of Faraday rotation angles is studied, and associated use of it is displayed through a program for which documentation is included. 3) Characteristics of scintillations in the weak and strong scatter regimes. Results of the frequency dependence of scintillations, power spectra, and autocorrelation of amplitude fluctuations are discussed. 4) Daytime VHF scintillations. Type 1, type 2, and E/sub sq/ irregularities are discussed. 5) A modification to the Signal Analysis Package, previously developed, is described. Application for use on the CDC 6600.

42180 (N—76-24798) **F_2 peak electron densities in the main trough region of the ionosphere.** Halcrow, B.W. (Pennsylvania State Univ., University Park (USA). Ionosphere Research Lab.). May 1976. Contract NGL-39-009-003. 57p. (NASA-CR—147053; PSU-IRL-IR—55). NTIS $4.50.

A study of the main trough in the F2 region was made using observations from Alouette I and II. Parameters needed to predict the occurrence of the trough were determined from the many observations. These parameters were used to develop a modification factor for use with C.E.I.R. model of predicted MmF2. This modification factor reduced the C.E.I.R. model predicted NmF2 to more representative values of MmF2 in the main trough region.

42181 (N—76-27753) **Ionospheric R-region electron density and neutral atmosphere variations.** Stick, T.L. (Pennsylvania State Univ., University Park (USA). Ionosphere Research Lab.). Aug 1976. Contract NGL-39-009-003. 48p. (NASA-CR—148456; PSU-IRL-SCI—443). NTIS $4.00.

Electron density deviations from a basic variation with the solar zenith angle were investigated. A model study was conducted in which the effects of changes in neutral and relative densities of atomic and molecular oxygen on calculated electron densities were compared with incoherent scatter measurements in the height range 100—117 km at Arecibo, Puerto Rico. The feasibility of determining tides in the neutral atmosphere from electron density profiles was studied. It was determined that variations in phase between the density and temperature variation and the comparable magnitudes of their components make it appear improbable that the useful information on tidal modes can be obtained in this way. (Author) (GRA)

42182 (N—76-28715) **Ionospheric plasma cloud dynamics. Final report.** (Science Applications, Inc., La Jolla, Calif. (USA)). Jul 1976. Contract NASW-2602. 40p. (NASA-CR—148507; SAI—76-680-LJ). NTIS $4.00.

Measurements of the thermospheric neutral wind and ionospheric drift made at Eglin AFB, Florida, and Kwajalein Atoll are discussed. The neutral wind measurements at Eglin had little variation over a period of four years for moderate magnetic activity (Kp 4); the ionospheric drifts are small. Evidence is presented that indicates that increased magnetic activity has a significant effect on the neutral wind magnitude and direction at this midlatitude station. The neutral wind at dusk near the equator is generally small although in one case out of seven it was significantly larger. Use of observations of large barium releases to infer the degree of electrodynamic coupling of ion clouds to the background ionosphere is described. Evidence is presented that indicates that large barium releases are coupled to the conjugate ionosphere at midlatitudes. (auth)

42183 (N—76-28719) **Response of the ionosphere to the injection of chemically reactive vapors.** Bernhardt, P.A. (Stanford Univ., Calif. (USA). Radioscience Lab.). May 1976. Contracts NAS8-31769;NGR-05-020-001. 262p. (NASA-CR—149941; SU-SEL—76-009). NTIS $9.00.

As a gas released in the ionosphere expands, it is rapidly cooled. When the vapor becomes sufficiently tenuous, it is reheated by collisions with the ambient atmosphere, and its flow is then governed by diffusive expansion. As the injected gas becomes well mixed with the plasma, a hole is created by chemical processes. In the case of diatomic hydrogen release, depression of the electron concentrations is governed by the charge exchange reaction between oxygen ions and hydrogen, producing positive hydroxyl ions. Hydroxyl ions rapidly react with the electron gas to produce excited oxygen and hydrogen atoms. Enhanced airglow emissions result from the transition of the excited atoms to lower energy states. The electron temperature in the depleted region rises sharply and this rise causes a thermal expansion of the plasma and a further reduction in the local plasma concentration. (GRA)

42184 (N—76-28723) **Rocket-borne time-of-flight mass spectrometry.** Reiter, R.F. (Pennsylvania State Univ., University Park (USA). Ionosphere Research Lab.). Aug 1976. Contract NGR-39-009-032. 239p. (NASA-CR—148504; PSU-IRL-SCI—444). NTIS $8.00.

Theoretical and numerical analyses are made of planar-, cylindrical- and spherical-electrode two-field time-of-flight mass spectrometers in order to optimize their operating conditions. A method is introduced which can improve the resolving power of these instruments by a factor of 7.5. Potential barrier gating in time-of-flight mass spectrometers is also analyzed. Experimental studies of a miniature cylindrical-electrode and a hemispherical-electrode time-of-flight mass spectrometer are presented. Their sensitivity and ability to operate at D-region pressures with an open source make them ideal instruments for D-region ion composition measurements. A sounding rocket experiment package carrying a cylindrical electrode time-of-flight mass spectrometer was launched. The data indicate that essentially 100% of the positive electric charge on positive ions is carried by ions with mass-to-charge ratios greater than 500 below an altitude of 92 km. These heavy charge carriers were present at altitudes up to about 100 km. (auth)

42185 (N—76-29782) **Study of the conditions necessary for the onset of mid-latitude spread F.** Zinchenko, G.N. (Pennsylvania State Univ., University Park (USA). Ionosphere Research Lab.). 3 Aug 1976. Contract NGL-39-009-003. 46p. (NASA-CR—148597; PSU-IRL-SCI—445). NTIS $4.00.

Ionospheric conditions associated with the initiation of spread F in the mid-latitude ionosphere were observed. The morphology of spread F at Puerto Rico was investigated. Data from 7 nights were examined for Arecibo, five with spread F and two without. The relative height of the F layer maximum and the vertically integreted Pedersen conductivity, the relation between E and F region conductivities, the coupling lengths between the E and F regions, and vertical and horizontal gradients of electron density were examined. At Millstone Hill 13 nights were examined for all of which spread F was observed. The EW and NS velocities and the vertical velocities and the electric—ion temperature ratio were examined. (auth)

42186 (PB—256 102) **The correlation of the 10 to 30 MeV proton flux from the NOAA satellites and the Thule 30 MHz riometer. Technical memo.** Gardner, L.J. (National Oceanic and Atmospheric Administration, Boulder, Colo. (USA). Space Environment Lab.). Jun 1975. 11p. (NOAA-TM-ERL-SEL—41). NTIS $3.50.

There is a requirement for realtime specification of riometer absorption in the polar cap region using proton flux measured with satellite-borne detectors. The proton flux data from the NOAA series of satellites and the Thule 30 MHz riometer data satisfy this requirement. A study was done to correlate these two parameters within state-of-the-art theoretical reasoning. (GRA)

EFFECTS OF NUCLEAR DETONATIONS

42187 (AD-A—028516) **Experimental validation of transient plasma effects used in high altitude electromagnetic pulse calculations. Final report.** Carlile, R.N. (Arizona Univ., Tucson (USA)). Jun 1976. Contract F29601-75-C-0082. 22p. NTIS $3.50.

The work discussed in this report concerns the propagation of an electromagnetic pulse (EMP) through the high altitude EMP source region. The objective of this work has been to obtain experimental data on the nonlinear absorption of an EMP by conduction currents within the high altitude EMP source region that could be compared with theoretical predictions. (GRA)

42188 (AD-A—030059) **Experimental study of the nonlinear propagation of an electromagnetic pulse through the ionosphere. Final report Jun 1974—Jan 1975.** (Arizona Univ., Tucson (USA). Dept. of Electrical Engineering). Jul 1976. Contract F29601-74-C-0110. 62p. NTIS $4.50.

This report is concerned with the experimental investigation of EMP propagation through the D-region of the ionosphere. High and low amplitude EMP signals can propagate into space and pose a potential threat to satellites. The Air Force Weapons Laboratory (AFWL) had developed a theory which predicts that when an EMP propagates through the D-region of the ionosphere, that considerable energy can be absorbed from this pulse, thus reducing its potential threat. A plasma machine was built in which pulse propagation in the ionosphere can be simulated. A TEM waveguide is immersed in a nitrogen plasma. A pulse was applied which simulated an EMP to the input. The received signal was observed at the output. A probe which can measure the electron distribution function allows one to monitor the electron temperature. Thus, energy absorbed from the pulse and electron temperature can be monitored. Other diagnostic systems allow many other quantities to be monitored. (auth)

MAGNETOSPHERIC PHENOMENA

REFER ALSO TO CITATION(S) 42164, 42171, 42254

42189 (AD-A—034731) **Report on the geophysical description and available data associated with rocket PF-NH-89 (IC 507.11-2a).** Romick, G.J. (Alaska Univ., College (USA). Geophysical Inst.). Jan 1976. Contract F19628-74-C-0188. 40p. NTIS, PC A03/MF A01.

Report on High Altitude Effects Simulation Program. See also report dated Jan 76, AD-A—034381.

A Nike-Hydac rocket was launched at 09:12:20 UT on March 10, 1975 from Poker Flat Research Rocket Range. This rocket reached an apogee altitude of 152 km with a total flight time greater than 454 seconds. The payload was successfully recovered. The rocket was launched during an intense auroral substorm (-600 gamma in delta H) into a westward traveling surge. The sky at Ester Dome and Ft. Yukon was clear. No meridian scanning photometer data were recorded at either Ft. Yukon or Ester Dome due to camera malfunction. However, analysis of the ground ASC data recorded at Ester Dome and Ft. Yukon can be used to assist in determining the relationship of the on-board data to the aurora.

42190 (AD-A—034783) **Observations of ion cyclotron waves within the plasmasphere by Hawkeye-1. Progress report.** Kintner, P.M.; Gurnett, D.A. (Iowa Univ., Iowa City (USA). Dept. of Physics and Astronomy). Dec 1976. Contract N00014-76-C-0016. 27p. NTIS, PC A03/MF A01.

A survey of the plasma wave data from the Hawkeye-1 spacecraft has been performed in search of ion cyclotron waves associated with the scattering and loss of ring current ions within and near the plasma-pause. During an 18 month period, consisting of about 270 orbits, a total of 5 events have been found with clearly detectable electric and magnetic fields at frequencies below the proton gyrofrequency. Comparisons of the electric and magnetic field amplitudes for these events provide strong evidence that these waves are ion cyclotron waves. All five events occurred during the recovery phase of a magnetic storm at radial distances within or very close to the plasmapause boundary. The results of this survey confirm and are consistent with the earlier identification of ion cyclotron waves by the Explorer 45 satellite. The Hawkeye-1 observations show that ion cyclotron waves of substantial amplitude occur at magnetic latitudes well away from the magnetic equator.

42191 (N—76-27752) **Terrestrial kilometric radiation: 2-emission from the magnetospheric cusp and dayside magnetosheath.** Alexander, J.K.; Kaiser, M.L. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Jun 1976. 28p. (NASA-TM-X—71152;X—695-76-139). NTIS $4.00.

Subm-Submitted for Publication.

Measurements of the location of sources of terrestrial kilometric radiation obtained with the lunar orbiting Radio Astronomy Explorer-2 satellite have revealed a class of emission associated with the cusp and dayside magnetosheath. At frequencies near 250 kHz this emission is observed at radial distances between 2 and 20 R/sub E/ at magnetic latitudes of 75 deg to 80 deg and is most often detected during periods of auroral activity (AE approximately = 250) and southward orientation of the interplanetary magnetic field vertical component. During very disturbed times, the emission at the lowest frequencies (< or approximately= 200 kHz) appears to come from the dayside magnetosheath at distances approximately = 12 R/ sub E/. Whenever the geomagnetic dipole is tilted significantly with respect to the ecliptic pole (< or approximately = 10 deg) the cusp emission is confined to the hemisphere containing the subsolar point. The measurements also suggest that the region of cusp emission is rather narrowly confined in longitude to within +- a few hours of the noon meridian. (auth)

42192 (N—76-27758) **Multisatellite study of auroral zone phenomena. Part 2: observations during a substorm period on 11 November 1969.** Rossberg, L.; Burrows, J.R.; Kirsch, E.; Muench, J.; Riedler, W. (Max-Planck-Institut fuer Aeronomie, Katlenburg-Lindau (Germany, F.R.). Inst. fuer Stratosphaeren-Physik). Apr 1976. 70p. (ESA-SR—25). NTIS $4.50.

Observations of electrons and protons over the auroral zone, the interplanetary magnetic field direction and the magnetic activity and cosmic noise absorption are used to study the changing disturbance pattern during a typical substorm period on 11 November 1969. The results are compared with the magnetically less disturbed period from 00 to 10 UT on the same day. It is demonstrated that the magnetic substorm can be used to determine the maximum phase of the magnetospheric activity but neither the onset nor the end. (auth)

42193 (N—76-27751) **Polar aurora in the magnetosphere.** Galperin, Y.I. Jul 1976. Translation of Polyarnyye Siyaniya V magnitosfere, Moscow, Znaniye Press, 1975, p 1-64. (NASA-TT-F—17106). 83p. NTIS $5.00.

The study of physical processes in the near-Earth plasma has held and holds an important place in programs of space research. The causes of appearance of hot plasma in the magnetosphere, its movement, heating and the absorption of its energy in the upper atmosphere, which cause the Polar Aurorae and magnetic storms are described. Also decribed are various experiments conducted for the study of these phenomena. Specifically, descriptions are given of the latest results of the experimental study of the magnetospheres of other planets - Mercury, Mars, and Jupiter - as well as certain hypotheses regarding the characteristics of the structure of the as yet inaccessible magnetospheres of Saturn and Uranus. Reference is made to U.S. Space Programs and U.S.S.R. Space Programs where applicable. The information that is presented is intended for specialists, teachers and students of higher educational institutions, public school teachers, as well as all those interested in studying space. (auth)

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

BEAMS AND THEIR REACTIONS

REFER ALSO TO CITATION(S) 41926

COLLISION PHENOMENA

REFER ALSO TO CITATION(S) 42195

42194 (N—76-30320) **Infrared spectroscopic measurements and analysis. Final report, Jan 1975—Mar 1976.** Birnbaum, G. (Rockwell International Corp., Thousand Oaks, Calif. (USA). Science Center). 5 Mar 1976. Contract NAS5-20820. 24p. (NASA-CR—144793;SC—5015.2FR). NTIS $3.50.

The collision induced spectrum in equilibrium $H_2(eH_2)$ and in equilibrium H_2—He mixtures have been determined at densities below 120 amagat in the region 500 to 900 cm/1 at 293, 195, and 77K. The collision induced spectrum of normal H_2 at 77K in the region 25 to 490 cm/1 has also been determined. The details of the experiment, experimental results, and comparison with previous results are presented. A report dealing with a new theory of the shape of pressure induced spectra with an application to the far infrared spectrum of eH_2 at 77K is appended. (auth)

GENERAL FLUID DYNAMICS

REFER ALSO TO CITATION(S) 40783

PROPERTIES AND STRUCTURE OF FLUIDS

42195 (N—76-29018) **Electron Boltzmann equation in a plasma generated by fission fragments.** Hassan, H.A.; Deese, J.E. (North Carolina State Univ., Raleigh (USA)). Jul 1976. 31p. (NASA-CR—2712). NTIS $4.00.

A Boltzmann equation formulation is presented for the determination of the electron distribution function in a plasma generated by fission fragments. The formulation takes into consideration ambipolar diffusion, elastic and inelastic collisions, recombination and ionization, and allows for the fact that the primary electrons are not monoenergetic. Calculations for He in a tube coated with fissionable material show that, over a wide pressure and neutron flux range, the distribution function is non-Maxwellian, but the electrons are essentially thermal. Moreover, about a third of the energy of the primary electrons is transferred into the inelastic levels of He. This fraction of energy transfer is almost independent of pressure and neutron flux, but increases sharply in the presence of a sustainer electric field. (auth)

MAGNETOHYDRODYNAMICS

REFER ALSO TO CITATION(S) 42240

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

ELECTROMAGNETIC INTERACTIONS

42196 (N—76-27996) **Threshold effects in annihilation processes.** Renard, F.M. (Montpellier-2 Univ., 34 (France). Dept. de Physique Mathematique). Feb 1976. 21p. (PM—76/4). NTIS, PC A02/MF A01.

The quark exchange diagram is shown to lead to enhancements in the production of quasi-two-body states near their threshold. An application is given for heavy meson production in the 4- to 4.5-GeV bump of the e^+e^- yields hadrons reaction cross section. Similar bumps in the 1 to 2 GeV region are discussed in the case of N,N bar; a final state interaction is added and a sharp peak in N,N

bar or pion production cross section is predicted at 5s = 2 GeV. A total enhancement of order 10 nb is then obtained in the cross section for e^+e^- hadrons. (GRA)

NUCLEAR PHYSICS

REFER ALSO TO CITATION(S) 41936

42197 (Juel-Conf—16(Vol.2), pp 11-33) **Experimental status of high-spin states.** Stephens, F.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Dec 1975.

From Conference on highly excited states of nuclei; Julich, F.R. Germany (22 Sep 1975).

12 figs.; 28 refs.

In International symposium on highly excited states in nuclei. Vol. 2.

In the paper a review of the implications of high spin states for the nuclear structure is given: Loss of pairing correlations, changes in the nuclear shape and nuclear alignment. The experimental methods to populate high spin states in reactions and their measuring methods are reported. High spin states in heavy ion reactions are discussed in particular.

EXPERIMENTAL TECHNIQUES

42198 Comprehensive formalism for the analysis of recoil-distance lifetimes. Sturm, R.J.; Guidry, M.W. (Oak Ridge National Lab., Tenn. (USA)). *Nucl. Instrum. Methods;* **138**: No. 2, 345-351(15 Oct 1976).

A comprehensive and essentially rigorous formalism for the analysis of recoil-distance data is developed, and a computer code implementing this formalism is described.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19 THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

42199 Time-dependent Hartree-Fock calculation of $^{12}C+^{12}C$ with a realistic potential. Maruhn, J.A. (Oak Ridge National Lab., Tenn. (USA)); Cusson, R.Y. (Duke Univ., Durham, N.C. (USA). Dept. of Physics). *Nucl. Phys., A;* **270**: No. 2, 471-488(19 Oct 1976).

A realistic single-particle K-matrix model has been used to compute the head-on scattering of $^{12}C+^{12}C$ at incident projectile lab energies of 3.2, 6.4, 12.8, 19.2, 25.6, 32, 51.2 and 64 MeV/nucleon, above the Coulomb barrier, in the time-dependent Hartree-Fock approximation. Direct and exchange Coulomb forces as well as spin-orbit forces are included. A large deformed harmonic oscillator basis is used. Spatial density and current distributions at various times are shown. The outgoing energy is found to be E_0=0.8E/sub in/-28 (MeV), in the c.m. system. Fusion and fully relaxed scattering are observed at low energy. Some compression is seen at higher energies but no shock waves can be detected. Consequences for heavy-ion reactions are discussed.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

42200 Cross section for the $^9Be(n,t_1)^7Li$ reaction between 13.3 and 15 MeV. Dietrich, F.S.; Hansen, L.F.; Koopman, R.P. (Lawrence Livermore Lab, Calif). *Nucl. Sci. Eng.;* **61**: No. 2, 267-269(Oct 1976).

The magnitude and energy dependence of the $^9Be(n,t_1)^7Li$ reaction have been measured between 13.3- and 15-MeV neutron energy by observing the gamma decay of the first excited state of Li with a Ge(Li) detector. A ring and shadow-cone geometry was used. The results are in disagreement with a previous measurement of this cross section. This reaction is of interest in fusion reactor design as a source of tritium evolution.

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

42201 Neutron absorption cross section of sodium 22. Rundberg, R.; Elgart, M.F.; Finston, H.L.; Williams, E.T.; Bond, A.H. Jr. (Brooklyn Coll.). pp 792-794 of In Nuclear cross sections and technology. Vol. I and II. Schrack, R.A.; Bowman, C.D. (eds.). Washington, DC; National Bureau of Standards (Oct 1975).

From Conference on nuclear cross sections and technology; Washington, DC, USA (3 Mar 1975).

A simple method is described for determining the neutron absorption cross sections for radionuclides produced and consumed in a reactor-neutron flux. Data were obtained for ^{22}Na which, through application of Westcott's procedure, yielded the following: sigma$_0$ = 51.1 +- 3.1 Kbarns, s_0 = 2.3 +- 0.1, and Σ' = 100 +- 10 Kbarns.

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

42202 Energy dependence of the optical model parameters for α-particles scattered from ^{40}Ca and ^{58}Ni. Chang, H.H.; Ridley, B.W. (Colorado Univ., Boulder (USA). Nuclear Physics Lab.); Braid, T.H. (Argonne National Lab., Ill. (USA)); Conlon, T.W. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment); Gibson, E.F. (California State University, Sacramento, California, USA); King, N.S.P. (California Univ., Davis (USA). Crocker Nuclear Lab.). *Nucl. Phys., A;* **270**: No. 2, 413-427(19 Oct 1976).

The differential cross sections for α-particles elastically scattered from ^{40}Ca and ^{58}Ni at seven different bombarding energies up to 85.6 MeV are reported. The results of optical model analyses yielded energy dependent optical potential parameter sets which are given, as well as individual best-fit parameters. For a given real radius parameter, an analytical expression is found to explain satisfactorily the difference in energy dependence of the real potential depth between two discrete potential families. For α-particle energies less than 80 MeV, the potential parameters and especially the individual best-fit parameters for the two discrete potential families vary strongly but systematically with energy. Similar anomalous energy dependence in the potential parameters was also observed when an improved form for the real potential was used. The analysis of the data indicated that the potential family which has the normalized volume integral of the real potential J/sub R/ approximately 350 MeV . fm^3 is the most appropriate for α-particle scattering.

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, EXPERIMENTAL

MASS, ABUNDANCE, AND BINDING ENERGY

42203 (N—76-30045) **Isotopic shift between the even numbered Sr isotopes 84, 86, 88 and 90 and the jump in nuclear volume effect in the case of neutron count 50.** Heilig, K. Translated from *Z. Phys.;* **161**: 252-266(1961). 23p. (NASA-TT-F—17150). NTIS $3.50.

A recording Fabry—Perot spectrometer was used to investigate enriched isotopes. The isotope displacements of stable 84, 86 and 88 isotopes has the sign of the nuclear mass effect; that of isotope 88 with respect to radioactive 90 isotope has the sign of the nuclear volume effect. The same thing was found for the Sr I resonance line. (auth)

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

42204 Average neutron resonance parameters and radiative capture cross sections for the isotopes of molybdenum. de Musgrove, A.R. L.; Allen, B.J.; Boldeman, J.W. (Australian Atomic Energy Commission Research Establishment, Lucas Heights); Macklin, R.L. (Oak Ridge National Lab., Tenn. (USA)). *Nucl. Phys., A;* **270**: No. 1, 108-140(12 Oct 1976).

The neutron capture cross sections of the stable molybdenum isotopes have been measured with high energy resolution ($\Delta E/E <$ approximately 0.2%), between 3 and 90 keV neutron energy, at the 40 m station of ORELA. Average resonance parameters are extracted for s- and p-wave resonances. The s-wave neutron strength function is close to 0.5×10^{-4} for all isotopes, but the p-wave strength

function exhibits a well defined peak near A approximately 95. Both s- and p-wave radiative widths decrease markedly as further neutrons are added to the closed shell. The p-wave radiative widths are generally greater than the s-wave widths showing the presence of non-statistical γ-decay mechanisms. Valence neutron theory fails to explain the magnitude of the p- to s-wave radiative width disparity and doorway state processes are invoked. In particular, the data for ^{98}Mo appear to violate the usual valence theory, since the correlations between radiative and neutron strengths are small. Further, the radiative widths are smaller than can be explained on the valence model. An explanation for the loss of valence strength is advanced. Interpolated resonance parameters allow an estimate for the unknown cross section for ^{99}Mo(n, γ).

42205 Nuclear and Coulomb deformation parameters in ^{142}Nd. Thornton, S.T.; Schweizer, T.C.; Gustafson, D.E. (Virginia Univ., Charlottesville (USA). Dept. of Physics); Ford, J.L.C. Jr. (Oak Ridge National Lab., Tenn. (USA)); Levine, M.J. (Brookhaven National Lab., Upton, N.Y. (USA)). *Nucl. Phys., A;* **270**: No. 2, 428-436(19 Oct 1976).

Nuclear and Coulomb deformation parameters have been deduced from DWBA analyses of angular distributions of 67.5 MeV ^{13}C ions inelastically scattered from ^{142}Nd. Optical model parameters from fits of measured elastic scattering data were used with previously measured B(EL) values to determine initial deformation parameters. Comparison with the experimental data indicates that DWBA calculations can be used to understand the inelastic scattering from the nearly spherical nucleus ^{142}Nd.

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, THEORETICAL

REFER ALSO TO CITATION(S) 41460

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

42206 (INIS-mf—3352, pp 15) **Study of the ^{238}U(n,γ)^{239}U reaction.** Kopecky, J. (Stichting voor Fundamenteel Onderzoek der Materie, Utrecht (Netherlands); Stichting Energieonderzoek Centrum Nederland, Petten); Chrien, R.E.; Lion, H.I. (Brookhaven National Lab., Upton, N.Y. (USA)). 15 Oct 1976.

From Nederlandse Natuurkundige Vereniging, Sectie Kernfysica, autumn meeting; Groningen, Netherlands (22 Oct 1976). Published in summary form only.

In Autumn meeting.

SPONTANEOUS AND INDUCED FISSION

42207 Central collisions of relativistic heavy ions. Gutbrod, H.H. (Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt (F.R. Germany); California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *J. Phys. (Paris), Colloq.;* No. 5, C5.209-C5.212(1976).

From European conference on nuclear physics with heavy ions; Caen, France (6 Sep 1976).

Relativistic heavy ion collisions are pragmatically subdivided into peripheral and central collisions. In peripheral collisions, the target and projectile nuclei interact only in the tails of their density distributions. Therefore, only a small amount of energy and momentum is transferred and the multiplicities are small. In more central collisions, large amounts of nuclear matter interact and events have a high multiplicity. Some data of double differential cross sections are presented from measurements for high energy p, d, t, ^{3}He, and ^{4}He particles emitted from uranium targets irradiated with ^{20}Ne ions at 250, 400 and 2100 MeV/nucleon and ^{4}He ions at 400 MeV/nucleon. The shape and yield of the proton energy spectra were used to obtain the shape and yield of the d, t, ^{3}He, and ^{4}He energy spectra at all measured angles for all incident energies, assuming that they are formed by coalescence of cascade nucleons. A model analogous to that of Butler, Pearson, and Schwarzschild and Zupancic was used. The overall features of the proton inclusive spectra are shown to be fitted without any adjustable parameter by a nuclear fireball model.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 42201

RADIATION AND SHIELDING PHYSICS

RADIATION PHYSICS

42208 (AD-A—034754) **FLAIR: a scaling and folding code for the generation of photon transport results in air. Final report.** Scott, W.H. Jr.; Colborn, B.L. (Science Applications, Inc., La Jolla, Calif. (USA)). Dec 1976. Contract DAAD05-73-C-0154. 80p. NTIS, PC A05/MF A01.

The FLAIR code was developed to generate x-ray and gamma-ray transport results in infinite air easily and inexpensively by utilizing an existing data base of x- and gamma-ray transport computed by Monte Carlo. FLAIR provides energy, angle, and time-dependent photon transport results from energy and time-dependent photon sources in infinite air. Results are possible out to ranges of fifteen mean-free-paths and are scaled with air density. FLAIR is oriented toward benchmarking radiation environments from weapon systems and calculating differential fluxes for input to radiation response codes.

NEUTRON INTERACTIONS WITH MATTER

REFER ALSO TO CITATION(S) 41462, 42018, 42019, 42020, 42021, 42022, 42023, 42024, 42025, 42026, 42027, 42290

SOLID STATE PHYSICS

REFER ALSO TO CITATION(S) 41862

42209 (AD-A—031022) **Theory of solid surfaces. Final scientific report 1 Oct 1972—30 Sep 1975.** Inkson, J.C.; Anderson, P.W. (Cambridge Univ. (UK). Cavendish Lab.). 1 May 1976. 46p. NTIS $4.00.

A wide range of work is described on surface and bulk properties of materials. Work upon metal—semiconductor interfaces and its application to Schottky barriers and photoemission is described. Related to this is the continuing investigation into surface induced superconductivity, and reasons are suggested as to why the goal may be illusionary. The developments of the calculation of the optical scattering potential for surface scattering (as in LEED) are described, and its gross properties are explained in terms of a simple model. The application of local methods to semiconductors can be applied to a large range of surface problems. Two developments are described here, on bulk properties, the calculation of the dielectric response, and the application of the Anderson chemical, pseudopotential to a range of bulk properties of semiconductors and 'non-simple' materials. This last method shows promise of connecting solid state physics to the more chemical ideas of bond properties. Also, using a local method, we describe some promising work on the Laves phases of transition metal alloys which are too complicated to calculate in the normal K-space form but have important technical applications. Finally, in solids, we describe the recent work on spin glasses which breaks new ground in the understanding of this system and has important consequences for the theory of a number of polymer related problems. (GRA)

SUPERCONDUCTIVITY

REFER ALSO TO CITATION(S) 41862, 42209

GENERAL THEORY

REFER ALSO TO CITATION(S) 41810

ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA

REFER ALSO TO CITATION(S) 41808, 41809

42210 (AD-A—034361) **Superconductors, magnetic detectors and magnetic electronics. Final report.** Tinkham, M. (Harvard Univ., Cambridge, Mass. (USA). Div. of Engineering and Applied Physics). 10 Nov 1976. Contracts N00014-76-C-0032;N00014-67-A-0298-0022. 11p. NTIS, PC A02/MF A01.

Work in opening up the far infrared spectrum to useful application in the study of solids is reported, i.e., finding and studying the energy gap in superconductors, first observation of antiferromagnetic resonance and exchange resonances in the far infrared, first observation of the temperature-dependent soft mode in ferroelectric crystals, first observation of the far-infrared absorption due to random charge in disordered systems, the effect of magnetic fields in creating gapless superconductors and the implications of fluxoid quantization for the critical fields of thin films and bulk superconductors.

FUSION ENERGY

PLASMA RESEARCH

PLASMA CONFINEMENT AND HEATING

42211 (AED-Conf—76-506-008) **Confinement studies in Culham stellarators with ohmic heating currents.** Atkinson, D.W.; Bradley, J.; Dellis, A.N.; Gill, R.D.; Hamberger, S.M.; Lees, D.J.; Lister, J.B.; McKay, W.; Malein, A.; Millar, W. (UKAEA Research Group, Abingdon. Culham Lab.). 1976. 9p. (IAEA-CN—35/D1; CONF-761012—71). Dep. NTIS (US Sales Only), PC A02/MF A01.

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, German, Federal Republic of (F.R. Germany) (6 Oct 1976).

8 figs.; 1 tab.; 10 refs. Available from the IAEA.

In the CLEO apparatus, Tokamak and ohmically-heated stellarator plasmas have been directly compared, for gas currents of 10-25 kA and Bphi = 12.7 kG. The vacuum poloidal field due to the helical winding has a considerable influence on the containment properties. In particular, for the same current the electron energy content is twice as great in the stellarator as in the Tokamak. In the TORSO apparatus the confinement has been studied as a function of drift parameter phi = vsub(d)/vsub(e). For phi $<=$ 0.02, when the plasma is collisional, the confinement scales in accordance with the predictions of classical theory for the Pfirsch-Schlueter regime. Electrostatic density fluctuations, apparently current-driven drift modes, increase in amplitude with phi and for phi $<$ 0.02 the confinement becomes increasingly determined by turbulent diffusion due to these modes.

42212 (COO—4020-3) **Study of flow and loss processes at the ends of a linear theta pinch. Progress report for the period June 1, 1976—May 31, 1977.** York, T.M.; Klevans, E.H. (Pennsylvania State Univ., University Park (USA)). Feb 1977. Contract EY-76-S-02-4020. 132p. Dep. NTIS, PC A07/MF A01.

Experimental and analytical studies initiating and supporting research on flow and energy losses at the ends of a linear theta pinch have been carried out. A 25 cm linear pinch coil has been driven by a 515,000 A discharge with 10 μsec half-cycle time supplied by a 100 μF, 18 kV energy storage system. With reliable preionization generated up to 400 mT He, current sheath behavior has been identified with magnetic loop probes and double loop probes. Spectroscopic determination of preionization has been made. A ruby laser Thomson scattering diagnostic has been designed and is being procured. A study of transient plasma behavior in a 10 cm theta pinch has been carried out with a Twyman-Green interferometer using a 7 mW He—Ne CW laser. Pressure, electric field, and velocity probe diagnostics have received preliminary testing. Design work has been completed for the doubling of pinch length and energy storage system. Studies of particle loss scaling and reactor scaling of linear theta pinch devices have been reported. Detailed calculations of plasma properties at the end of the pinch coil following expansion from the central coil have been carried out. A O—D, time dependent computer code that includes conduction, convection, and magnetic field diffusion has been developed. Predicted plasma behavior is in good agreement with experimental data.

42213 (EUR-CEA-FC—848) **Plasma heating by cluster injection: basic features and expected behaviour.** Bottiglioni, F.; Coutant, J.; Fois, M. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Aug 1976. 38p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The main components of a cluster injection line intended for plasma heating is briefly discussed, that is the beam source, the cluster ionizer and the accelerating tube, as well as the behavior of clusters interacting with a plasma. Outlines of the experiment of cluster injection into TFR, in progress at Fontenay-aux-Roses, and expected results will be presented and discussed all along the paper.

42214 (EUR-CEA-FC—855-TR) **Plasma heating in the TM-3 Tokamak at the electron cyclotron resonance in magnetic fields up to 25kGs.** Alikaev, V.V.; Bobrovski, G.A.; Poznyak, V.J.; Rasumova, K.A.; Sannikov, V.V.; Sokolov, Yu.A.; Chmarine, A.A. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee). Oct 1976. 12p. (In French). Dep. NTIS (US Sales Only), PC A02/MF A01.

Translated from Physica Plasmi (1976) v. 2(3) p. 390-395.

Plasma heating at the electron cyclotron resonance was studied in the TM3 tokamak for increased magnetic fields at the resonance, to obtain further confirmation of the heating of the main electron population. The results obtained using Thomson scattering and diamagnetic measurements were compared, and they revealed that main electron population heating effectively occurs. It was thus possible to study the variation of tausub(E) with Tsub(e). The decrease of the hyperfrequency radiation intensity when the ECR heating is stopped was studied. It was shown that the confinement time of the electron energy increases with their longitudinal energy. The value Bsub(J)=2.2 was obtained after ECR heating at the 2nd harmonics, when Hsub(z)=5kGs and J=4kA.

42215 (N—76-25021) **Condition for absolute confinement of alpha particles in axisymmetric tori.** Ikuta, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Feb 1976. 9p. (IPPJ—240). NTIS $3.50.

The necessary condition for an axisymmetric torus to act as an absolute trap of fusion generated alpha particles was investigated, under the assumption that the fusion reaction occurs only on the elliptic magnetic axis where the plasma pressure is maximum. It was found that more than 50% of fusion generated alpha particles can be absolutely trapped in the axisymmetric tori if the toroidal current is larger than 11 mA.

42216 (PPPL—1327) **Cross-field-current driven lower-hybrid instability and stochastic ion heating.** Yamada, M.; Owens, D.K. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Mar 1977. Contract EY-76-C-02-3073. 14p. Dep. NTIS, PC A02/MF A01.

A suprathermal electron beam is injected parallel to vector B in a low-β plasma. The sharp space-potential drop across the surface of the beam generates a strong cross-field current which in turn drives a modified two-stream instability at the lower hybrid frequency. Intense stochastic ion heating is observed with the onset of the instability, and the heating rate is found to be proportional to the wave energy.

42217 (PPPL—1329) **Conduction heat loss scaling in open field line geometries.** Chu, T.K.; Johnson, L.C. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Mar 1977. Contract EY-76-C-02-3073. 22p. Dep. NTIS, PC A02/MF A01.

A scaling law governing the cooling of a finite-length column due to electron thermal conduction loss at the column ends, where the magnetic field lines are intercepted by a cold material wall, is derived. In addition to the electron temperature, both the electron number density and the magnetic field strength are allowed to vary along the field lines. It is shown that the cooling of the column is not very sensitive to moderate spatial variations of number density and magnetic field strength and is well represented by a characteristic cooling time given by $\tau_{au_0} = 5/2\ nL^2/K_0$, where L is the column half-length and n and K_0 are the number density and coefficient of thermal conductivity at the midplane.

42218 (PPPL—1330) **Free expansion experiment on ATC.** Grisham, L.R.; Bol, K.; Hogan, J.T. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Mar 1977. Contract EY-76-C-02-3073. 34p. Dep. NTIS, PC A03/MF A01.

The transport of a tokamak plasma which has been freed from contact with a material limiter is studied. A small compression in major radius of the plasma in the ATC tokamak produced a free-standing discharge, similar except for scale to a possible configuration of the Tokamak Fusion Test Reactor. Diffusion speeds in the range 10 ms^{-1} were measured, and the evolution is readily modeled by a numerical transport model calculation. The experiment provides a successful preliminary test of the feasibility of this technique.

42219 **Plasma anomalous heating by a strong electromagnetic field.** Bajkov, I.S.; Silin, V.P. (AN SSSR, Moscow. Fizicheskij Inst.). *Zh. Tekh. Fiz.;* **45**: No. 12, 2465-2471(Dec 1975). (In Russian).

For English translation see the journal Sov. Phys. - Tech. Phys.

It is shown that a very strong electromagnetic field with a frequency close to the electron plasma frequency leads to the excitation of electrostatic turbulence and strong heating of the plasma electrons and ions in the hydrodynamic stage of development of the parametric instability. The average thermal energy of the electrons increases more rapidly than that of the ions by approximately the cube root of the mass ratio.

42220 **Technology of inertial confinement systems. Report on the IAEA advisory group meeting on the technology of inertial confinement experiments, Dubna, Union of Soviet Socialist Republics, 19-23 July 1976.** Pashinin, P. (AN SSSR, Moscow. Fizicheskij Inst.); Yonas, G. (Sandia Labs., Albuquerque, N.Mex. (USA)). *Nucl. Fusion;* **16**: No. 5, 875-877(1976).

Published in summary form only.

42221 **Moshchnaya 12-kanal'naya lazernaya ustanovka del'fin dlya sfericheskogo nagreva termoyadernykh misheney. (Dolphin high-power 12-channel laser unit for spherical heating of thermonuclear targets).** Basov, N.G.; Danilov, A.E.; Krokhin, O.N.; Kruglov, B.V.; Mikhaylov, Yu.A.; Sklizkov, G.V.; Fedotov, A.I.; Fedorov, A.N. Moscow; Physics Institute (1976). 67p.

The paper describes the powerful "Dolphin" 12-channel laser unit designed for high-temperature heating of thermonuclear targets

in spherical irradiation geometry. The installation includes a neodymium laser with maximum emission energy of approximately 10 kJ, light pulse duration of approximately 10^{-10}-10^{-9} s and emission divergence of 5 x 10^{-4} rad, a vacuum chamber in which the laser emission is interacted with the plasma, and a complex of facilities for diagnosing laser and plasma parameters. The optical arrangement and design particulars of the laser system are considered. An analysis is made of schemes for focusing emission onto the target, and the focusing system of the "Dolphin" installation is described. This system gives a high degree of symmetry of target irradiation with a maximum density of the flux at the target surface of approximately 10^{15} W/cm^2. The authors examine the main problems of physical research on a laser plasma and the principal diagnostic facilities for solving them.

42222 Analytical investigation of the optical mixing of two laser beams of identical frequencies in a spatially homogeneous collisionless plasma. Spyrou, O.; Meyer, J. (British Columbia Univ., Vancouver (Canada). Dept. of Physics). *Can. J. Phys.;* **54**: No. 24, 2387-2395(15 Dec 1976).

5 refs.

Two laser beams of the same frequency and intensity propagating in opposite directions are mixed in a uniform collisionless plasma. A standing longitudinal wave is excited and traps charged particles. Including trapped particle dynamics and making use of the properties of the Jacobi elliptic functions, an expression for the power and the energy absorbed by the plasma electrons is derived. It is found that the power varies sinusoidally with time. Then the energy density is plotted as a function of the variable E_{10}/ksub(L), E_{10} being the electric field intensity of the lasers, and the validity of the results is discussed.

PLASMA DIAGNOSTICS

REFER ALSO TO CITATION(S) 42212

42223 (AD-A—034405) **Optimum design of an intensity limited pinhole-scintillator, image converter camera model for simultaneous energy, spatial, and time resolution of soft x-rays. Final report, 15 Aug 1975—30 Jun 1976.** Nuttelman, R.A. (Frank J. Seiler Research Lab., United States Air Force Academy, Colo. (USA)). 30 Aug 1976. 32p. (FJSRL-TR—76-0012). NTIS, PC A03/MF A01.

This report describes the optimum design of a generalized pinhole-scintillator, image converter camera model offering simultaneous energy, spatial, and time resolution of soft x-rays. This type of diagnostic system is particularly suited to analysis of x-rays from intense plasma discharge sources such as plasma focus and electromagnetic implosion devices having emitting dimensions in the mm to cm range and pulse lengths of 10 -1000 nsec. The usual diffraction limited, optimum pinhole design for spatial resolution is not used since sufficient x-ray intensities are often not available from laboratory plasmas to take advantage of optimum pinhole resolution. Instead, the condition for obtaining optimum spatial resolution for the intensity limited case for given time and energy resolution requirements are derived. The controlling requirement of film exposure is satisfied. Graphical solutions of optimum pinhole-to-scintillator distance, optimum pinhole diameter, and spatial resolution at optimum conditons are presented as a function of a dimensionless exposure parameter beta for several values of plasma-to-pinhole distance. This form of solution presentation allows rapid analysis of the effects of equipment changes and different degrees of time and energy resolution upon optimum spatial resolution. (Author)

42224 (EUR-CEA-FC—838) **Electron temperature and density relaxations during internal disruptions in TFR Tokamak plasmas.** (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Jul 1976. 32p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Several diagnostics (soft X-ray, Thomson scattering, high frequency waves, and vacuum ultraviolet spectroscopy) have been used on TFR Tokamak plasmas in order to show that the soft X-ray relaxations are mainly due to electron temperature relaxations, with only small variations of the electron density. Values of ΔTsub(e0)/Tsub(e0) up to 17% and of Δnsub(e0)/nsub(e0) of a few % or less have been measured.

42225 (EUR-CEA-FC—862) **Measurement of the ion temperature in Petula from the Doppler broadening of impurity lines.** Clement, M.; Martin, J.E.; Weisse, J. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Service d'Ionique Generale). Nov 1976. 40p. (In French). Dep. NTIS (US Sales Only), PC A03/MF A01.

The impurities temperature in PETULA has been obtained with a high resolution spectrometer from the Doppler broadening. A critical study of the precision of the measurements has been made and the influence of the decharge reproductibility has been shown. Moreover, the measured temperature does not agree necessarily with the temperature in the region where the impurity concentration is the highest. Some solutions to improve the measurement precision are proposed.

42226 (LA—6727-MS) **Novel interferometer for the measurement of plasma density.** Jacobson, A.R. (Los Alamos Scientific Lab., N.Mex. (USA)). Mar 1977. Contract W-7405-ENG-36. 3p. Dep. NTIS, PC A02/MF A01.

This report describes an interferometer recently developed and tested in prototype form. The device combines certain features of predecessor interferometers but in a module which is simpler to use, subject to limitations on path-length and bandwidth.

42227 (Rijnhuizen—76-100) **CO_2-laser interferometer with direct read-out of phase-shift.** Hugenholtz, C.A.J.; Meddens, B.J.H. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Nov 1976. 11p. Dep. NTIS (US Sales Only), PC A02/MF A01.

9 figs., 2 refs.

A CO_2-laser interferometer with heterodyne detection has been built to measure electron densities integrated over the optical path through a plasma in the range of $3x10^{19}m^{-2}$ to $3x10^{23}m^{-2}$. The heterodyne detection is accomplished at an intermediate frequency of 300 kHz. A digital phase comparator is used to obtain direct density read-out. The time resolution is 10 μsec. With this interferometer it is possible to determine the increasing or decreasing character of fluctuations in the density.

42228 Study of far-infrared Michelson interferometry based on fast plasma scanning. Bartlett, D.V.; Hewitt, R.G.L.; Robinson, L.C.; Tait, G.D. (Sydney Univ. (Australia). School of Physics). *Infrared Phys.;* **17**: No. 2, 89-103(Mar 1977).

Fast far infrared (FIR) muliplex spectroscopy based on a plasma-scanned Michelson interferometer is studied. Experiments show that the interferometer has sub-millisecond time response and high spectral resolving power. In addition to the description of the experimental performance of the interferometer, two different methods of interferogram inversion are developed and discussed.

PLASMA KINETICS - GENERAL

42229 (INIS-mf—3404) **Shock tube study of the coefficient of thermal conductivity of helium, neon, argon and krypton.** Vrugt, P.J. (Technische Hogeschool Eindhoven (Netherlands)). 19 Nov 1976. 107p. Dep. NTIS (US Sales Only), PC A06/MF A01.

31 refs., 38 figs., 6 tables. Thesis.

This thesis describes an alternative method of determining the coefficients of thermal conductivity of monatomic gases by a shock tube study. As usual, the subject of investigation is the thermal boundary layer that develops at the end wall of the shock tube after shock wave reflection. It is shown that the coefficients of thermal conductivity can be determined in a given temperature range by measuring the density gradient in a single point inside the thermal boundary layer as a function of time. In doing so, no specific functional relationship between the coefficient of thermal conductivity and the temperature has to be preassumed which is an important advantage of the present method over previous experimental techniques.

42230 (N—76-28015) **X-ray emission from high temperature plasmas. Annual report, 1 Jul 1975—30 Jun 1976.** Harries, W.L. (Old Dominion Univ., Norfolk, Va. (USA). Research Foundation). Jul 1976. 40p. (NASA-CR—148313; PGS-TR-PH—76-39). NTIS $4.00.

The physical processes occurring in plasma focus devices were studied. These devices produce dense high temperature plasmas, which emit x rays of hundreds of KeV energy and one to ten billion neutrons per pulse. The processes in the devices seem related to solar flare phenomena, and would also be of interest for controlled thermonuclear fusion applications. The high intensity, short duration bursts of X rays and neutrons could also possibly be used for pumping nuclear lasers.

42231 (ORNL—5206(Vol.1)) **Atomic data for controlled fusion research.** Barnett, C.F.; Ray, J.A.; Ricci, E.; Wilker, M.I.; McDaniel, E.W.; Thomas, E.W.; Gilbody, H.B. (Oak Ridge National Lab., Tenn. (USA)). Feb 1977. Contract W-7405-ENG-26. · p. Dep. NTIS, PC A17/MF A01.

Presented is an evaluated graphical and tabular compilation of atomic and molecular cross sections of interest to controlled thermonuclear research. The cross sections are tabulated and graphed as a function of energy for collision processes involving heavy particles, electrons, and photons with atoms and ions. Also included are sections on data for particle penetration through macroscopic matter, particle transport properties, particle interactions with surfaces, and pertinent charged particle nuclear cross sections and reaction rates. In most cases estimates have been made of the data accuracy.

42232 Photo-excitation and photo-ionization ahead of a strong shock wave in argon. Pinegre, M.; Valentin, P. (CEA Centre d'Etudes de Vaujours, 93 - Sevran (France); Rouen Univ., 76 - Mont-Saint-Aignan (France)). *C. R. Hebd. Seances Acad. Sci., Ser. B;* 283(15) p. 421-424(8 Dec 1976). (In French).

Theoretical predictions of excited atoms and electron density ahead of a strong shock wave in argon are presented. Comparison with experimental results shows that the photochemical kinetic model used is inadequate.

PLASMA KINETICS - THEORETICAL

42233 (AED-Conf—76-506-002) **Neutrals and impurities in the Tokamak discharges.** Mercier, C.; Werkoff, F. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). 1976. 8p. (IAEA-CN—35/B8-1; CONF-761012—74). Dep. NTIS (US Sales Only), PC A02/MF A01.

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, German, Federal Republic of (F.R. Germany) (6 Oct 1976).

17 figs.; 14 refs. Available from the IAEA.

This paper is devoted to particular and detailed studies with the Fontenay-aux-Roses one-dimensional toroidal transport code. Studied are the repartition of the neutrals inside the plasma and the following subsequent points: a) the correction which must be added to the value of Tsub(i) obtained by analyzing the spectrum of the outgoing neutrals created inside the plasma by charge-exchange, b) the flux for a given energy and per unit of surface of the neutrals striking the walls. For the impurities the influence of some parameters on their accumulation is reviewed. Studied are also the effects of the friction between two species of impurity (oxygen and molybdenum) in the case of the injection of a puff of oxygen. Finally sawtooth oscillations are simulated in order to attempt to shed some light on this phenomenon.

42234 (AED-Conf—76-506-023) **Transport processes and instabilities in magnetically confined plasmas with Tsub(itau) approximately Tsub(etau).** Basu, B.; Coppi, B.; Molvig, K.; Pegoraro, F.; Haber, I.; Hui, B.; Palmadesso, P.; Papadopoulos, K.; Winsor, N. (Massachusetts Inst. of Tech., Cambridge (USA)). 1976. 14p. (IAEA-CN—35/B13; CONF-761012—72). Dep. NTIS (US Sales Only), PC A02/MF A01.

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, German, Federal Republic of (F.R. Germany) (6 Oct 1976).

2 figs. Available from the IAEA.

A series of instabilities and transport processes relevant to high temperature magnetically confined plasmas with almost equal electron and ion transverse temperature are presented.

42235 (ERDA—77-18) **Synopsis of the management of the fusion plasma theory effort of the Division of Magnetic Fusion Energy.** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Magnetic Fusion Energy). Jan 1977. 81p. Dep. NTIS, PC A05/MF A01.

The document has been divided into six chapters: Introduction, Areas of Concern, Programmatic Approach, Resource Management, Communications and Present Programs. Areas of Concern describes the technical difficulties that are encountered by the program. The Programmatic Approach describes the management procedures that have been adopted by the Branch to solve the technical problems. It also describes the administrative problems of that approach. Resource Management describes the process of selecting contractors. Communications, which makes the document complete from the management point of view, describes the media and channels of theory communications. Present Programs gives current budgets and presently funded contractors.

42236 (N—76-31018) **A note on the problems of plasma-neutral gas interaction.** Lehnert, B. (SEE CODE- 6140560 Kungliga Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik med Fusionsforskning). 21 Feb 1976. 14p. (TRITA-EPP—76-05). NTIS $3.50.

The presence of an immersed neutral gas affects the equilibrium and the instability and wave phenomena of magnetically confined plasmas. Attention is drawn to some areas for further research on plasma-neutral gas interaction, including the spatial distributions of plasma and neutral gas, relaxation times, constraints and limitations of gas blanket systems, interaction with radiation, oscillations and wave phenomena, and instabilities.

42237 Renormalized kinetic theories of anomalous transport due to hydrodynamic fluctuations in strongly magnetized plasma. Krommes, J.A. Princeton, NJ; Princeton Univ. (1975). 300p. University Microfilms Order No. 76-22,601.

Thesis (Ph. D.).

The theory of hydrodynamic fluctuations in thermal equilibrium magnetized plasma is considered. It has been observed that neither classical theory nor diffusing orbit theories are adequate to explain the 2-D computer experiments of Okuda and Dawson, relating to anomalous transport in strongly magnetized plasma. The failure is attributed to the absence in those theories of the effects of the hydrodynamic modes on the transport. To remedy this deficiency, a renormalized version of Williams' cumulant hierarchy for two-time fluctuation correlation functions is proposed which includes explicitly the nonclassical effects of low frequency, long wavelength hydrodynamic fluctuations. Rigorous projection operator expressions for the transport coefficients which describe the regression of the fluctuations are given. Both the fluid transport coefficients and the test particle diffusion coefficient are discussed. The general formalism is then applied to the specific case of ion shear viscosity μ in strongly magnetized 2-D plasma (ω/sub pi//Ω/sub i/ $\sim$ 1, where ω/sub pi/ is the ion plasma frequency and Ω/sub i/ is the ion gyrofrequency).

42238 Possible correlation of the neutron yield to the electromechanic work in Mather-type plasma focus devices. Bruzzone, H.A.; Kelly, H.J.; Milanese, M.M.; Pouzo, J.O. (Buenos Aires Univ. Nacional (Argentina). Facultad de Ciencias Exactas y Naturales). *Nucl. Fusion;* **16**: No. 5, 870-873(1976).

Letter-to-the-editor.

42239 Finite element approach to the computation of the MHD spectrum of straight noncircular plasma equilibria. Berger, D.; Gruber, R.; Troyon, F. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)). *Comput. Phys. Commun.;* **11**: No. 3, 313-323(Jun 1976).

A numerical scheme to compute the MHD spectrum of a straight plasma column of arbitrary cross section is described. It is based on a finite element expansion in terms of a carefully chosen set of basis functions. Numerical tests show that kink modes are well reproduced for plasmas of arbitrary low β but that the weakly growing internal modes are difficult to obtain in the low-β regime.

42240 Relativistic magnetohydrodynamics of an accelerating plasma. Ciubotariu, C.D. (Polytech Inst, Jassy, Rom). *J. Math. Anal. Appl.;* **55**: No. 2, 272-283(Aug 1976).

In analog to W.M. Irvine's tetrads of a rotating reference system, a tetrad field associated with a medium experiencing a linear acceleration is derived. This is used for a tetrad formulation of relativistic equations of a system composed of an accelerating plasma coupled to a frozen-in magnetic field. It is found that the magnetic and hydrodynamic variables are independent of the time in comoving coordinates, and it is shown that a steady flow with constant values of the unperturbed quantities is not possible. Some relativistic barometric formulas for magnetohydrodynamic systems which are not in thermodynamic equilibrium are obtained. 17 refs.

42241 Study of helical plasma equilibria. Hamada, Y.; Suzuki, Y.; Ohasa, K.; Fujiwara, M.; Miyamoto, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics). *Plasma Phys.;* **18**: No. 2, 889-896(Dec 1976).

The equilibrium of the plasma limited by the material limiter of the separatrix in the linear stellarator system was solved numerically by the finite difference method. The expansion and the deformation of the plasma column due to the longitudinal plasma current and the plasma pressure were obtained and were in agreement with the predicted values in the simple case where the analytical solutions were already found.

42242 Limitations on the radical acceleration of a plasma formed by an intense relativistic electron beam. Kilkenny, J.D. (Imperial Coll. of Science and Technology, London (UK). Dept. of Physics). *Plasma Phys.;* **18**: No. 12, 905-910(Dec 1976).

A one dimensional model of the behaviour of the plasma formed by a rigid intense relativistic electron beam is presented. At low pressures (100 mTorr) a rapid outward acceleration is predicted. This is due to the explosive j x B force experimentally observed. The azimuthal magnetic field is also convected, and once sufficient plasma is outside of the beam, an induced current forms, decelerating the plasma. Most of the energy extracted from the electron beam, goes into the magnetic field. When the electron beam switches off a conventional z pinch forms. Because of the ionization and previous plasma motion the mass loading of this pinch is low. A tight pinch forms of density and temperature 2 10^{16} cm^{-3} and 200 eV. A comparison is made with experimental results.

42243 Expansion of an electron cloud. Lonngren, K.E. (Wisconsin Univ., Madison (USA). Mathematics Research Center); Hirose, A. (Saskatchewan Univ., Saskatoon (Canada). Dept. of Physics). *Phys. Lett., A;* **59**: No. 4, 285-286(13 Dec 1976).

An analytical expression for the expansion of a thermalized electron cloud is obtained.

PLASMA PRODUCTION

REFER ALSO TO CITATION(S) 42254

42244 Spatial correlation between 1.06 μm laser irradiation and emitted current for a plane target. Drouet, M.G.; Bolton, R.; Kreffer, P.; Saint-Hilaire, G.; Szili, Z. (Hydro-Quebec, Montreal (Canada). Research Inst.). *Phys. Lett., A;* **59**: No. 3, 210-213(29 Nov 1976).

The distribution of current generated by the irradiation of a copper target with a 4 J, 30 ns, Nd-glass laser pulse was measured at the laser-plasma interface. Current distribution was compared with the irradiation distribution.

PLASMA INSTABILITIES

REFER ALSO TO CITATION(S) 42216

42245 (N—76-31015) **The m = 1 motion of a screw pinch measured by external magnetic probes.** Pochelon, A.; Keller, R. (Ecole Polytechnique Federale, Lausanne (Switzerland)). Jun 1976. 18p. (LRP—99/76). NTIS $3.50.

Subm-Sponsored by the Swiss Natl. Sci. Found.

Measurements of the m = 1 growing mode of a linear screw pinch by external dipole probes were compared with the recorded plasma motion on streak photographs. Good agreement was found up to a maximum amplitude which depends on plasma density and growth rate. (Author) (GRA)

42246 (PPPL—1337) **Nonlinear saturation of the dissipative trapped-electron instability.** Chen, L.; Berger, R.L.; Lominadze, J.G.; Rosenbluth, M.N.; Rutherford, P.H. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Mar 1977. Contract EY-76-C-02-3073. 16p. Dep. NTIS, PC A02/MF A01.

It is shown that trapped-electron induced scattering can be dominant over nonlinear ion Landau damping in the saturation of short-wavelength dispersive trapped-electron instabilities in tokamaks. Trapped-electron induced scattering transfers the wave energy to shorter wavelengths, where it can be dissipated by ion viscosity.

42247 (Rijnhuizen—76-99) **Macroscopic oscillation and deformation of the plasma in SPICA.** Mimura, M.; Kooijman, W.; Oomens, A.A.M. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Oct 1976. 15p. Dep. NTIS (US Sales Only), PC A02/MF A01.

12 figs., 12 refs.

By using a set of pick-up coils positioned around the minor circumference of the discharge tube, the stability behaviour of the screw-pinch plasma in SPICA is studied. The data-processing system, AD-converters combined with a conputer, enables us to treat a large number of signals. The signals from the pick-up coils are transferred to the computer and are expanded into a Fourier series. The m = 1 cosine oscillation in the rise phase suggests a screw-pinch model in which a plasma core is surrounded by a current layer and a vacuum region. An m = 2 deformation is found to correlate with the decay rate of the plasma current.

42248 Plasma thermonuclear cyclotron-magnetoacoustic instability. Belikov, V.S.; Kolesnichenko, Ya.I. (AN Ukrainskoj SSR, Kiev. Inst. Yadernykh Issledovanij). *Zh. Tekh. Fiz.;* **45**: No. 9, 1798-1807(Sep 1975). (In Russian).

12 refs.; for English translation see the journal Sov. Phys. - Tech. Phys.

It is shown that a small quantity of thermonuclear reaction products in a plasma is sufficient to excite magnetoacoustic cyclotron waves. Instability criteria are obtained. The instability is compared in a toroidal system and in a mirror system. We investigate the effectiveness of shear stabilization. It is shown that even with significant shear the system can still be unstable; however, the threshold value of the concentrations of reaction products is higher.

42249 Instability of electron disturbances in an accelerator with an electron closed drift. Shishkin, G.G.; Gerasimov, V.F. *Zh. Tekh. Fiz.;* **45**: No. 9, 1847-1854(Sep 1975). (In Russian).

For English translation see the journal Sov. Phys. - Tech. Phys.

The hydrodynamic approximation is used to consider instabilities of a plasma in the inhomogeneous electric and magnetic fields of an E-H accelerator. The instability conditions are derived. Experimental results are given for the high-frequency case in an accelerator in which the electrons are magnetized but the ions are not. The dependence on the discharge parameters is studied. The spatial localization region and the direction of wave propagation are determined. Theory and experiment are found to be in close qualitative agreement.

42250 Non-linear saturation of the dissipative trapped-ion mode by mode coupling. Cohen, B.I.; Krommes, J.A.; Tang, W.M.; Rosenbluth, M.N. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). *Nucl. Fusion;* **16**: No. 6, 971-992(1976).

The non-linear saturation of the dissipative trapped-ion mode is analysed. The basic mechanism considered is the process whereby energy in long-wavelength unstable modes is non-linearly coupled via vector E cross vector B convection to short-wavelength modes stabilized by Landau damping due to both circulating and trapped ions. In the usual limit of the mode frequency being small relative to the effective electron collision frequency, a one-dimensional nonlinear partial differential equation for the potential can be derived, as was first shown by LaQuey, Mahajan, Tang, and Rutherford. The stability and accessibility of the possible equilibria for this equation are examined in detail, both analytically and numerically. The equilibrium emphasized by LaQuey et al. is shown to be unstable. However, a class of non-linear saturated states which are stable to linear perturbations is found. Included in the analysis are the effects of both ion collisions and dispersion due to finite-ion-banana-width effects. Cross-field transport is estimated and the scaling of the results is considered for tokamak parameters (specifically those for the Princeton Large Torus). It is concluded that the anomalous cross-field transport can be much lower than the estimate of Kadomtsev and Pogutse, for relevant parameters near marginal stability for the linear modes.

42251 Anomalous diffusion of alpha particles in the non-linear trapped-ion regime. Inoue, S.; Itoh, K. (Tokyo Univ. (Japan). Dept. of Physics). *Nucl. Fusion;* **16**: No. 5, 867-868(1976).

Letter-to-the-editor.

42252 Frictional effects with neutrals and Rayleigh-Taylor instability of a compressible Hall plasma. Maheshwari, S.L.; Bhatia, P.K. (Jodhpur Univ. (India)). *Beitr. Plasmaphys.;* **16**: No. 4, 251-261(1976).

The effect of neutral gas friction is considered on the Rayleigh-Taylor instability of a compressible plasma in the presence of Hall currents. The prevailing magnetic field is assumed to be uniform and horizontal. It is shown that the solution is characterized by a variational principle. Based on the variational principle the dispersion relation is derived for a composite plasma, confined between two horizontal planes at a finite distance, in which the density is stratified in the direction of gravity according to the exponential law. It is found that the effect of collisions with neutrals, Hall currents and compressibility of the medium have destabilizing influence as the wave number range which is stable in their absence, is rendered unstable by their presence.

42253 Kinetic theory of MHD instabilities in a nonuniform plasma. Hasegawa, A. (Bell Labs., Murray Hill, N.J. (USA)). *Sol. Phys.;* **47**: No. 1, 325-330(Mar 1976).

From The Flare Build-up Workshop; Cape Cod, Mass., USA (8 Sep 1975).

Most of MHD instabilities originating from the nonuniformity of a plasma excite MHD surface wave. When the excited wave has a frequency ωsub(s) which corresponds to the local shear Alfven wave resonance (ωsub(s)=k(parallel)γsub(A)(x), where γsub(A) is the Alfven speed and k(parallel) is the wave number in the direction of the magnetic field), the surface wave resonant mode converts to the kinetic Alfven wave, the Alfven wave having a perpendicular wavelength comparable to the ion gyroradius and being able to propagate across the magnetic field. Various linear and nonlinear effects of this kinetic Alfven wave on the plasma are discussed including particle acceleration and heating. A specific example for the case of a MHD Kelvin-Helmholtz instability is given.

PLASMA WAVE PHENOMENA

42254 (AD-A—030924) **Waves and instabilities in steady-state high-beta plasmas. Final report 15 May 72—30 Jun 76.** Luhmann, N.C. Jr; Chen, F.F. (California Univ., Los Angeles (USA). Dept. of Electrical Sciences and Engineering). Jul 1976. 61p. (UCLA-ENG—7672). NTIS $4.50.

The generation of steady-state, high-density, fully-ionized plasmas in magnetically confined arcs and jets has been studied. Finite-beta waves and instabilities appropriate to the ionospheric and magnetospheric plasmas have been investigated. Anomalous resistivity due to instability produced turbulent fluctuations has been studied. Experimental simulations of laser—plasma interactions have been performed in the microwave region. (auth)

42255 Kinetic instability of a two-component plasma at gyrofrequency harmonics. Zlotnik, E.Ya. (Nauchno-Issledovatel'skij Radiofizicheskij Inst., Gorkij (USSR)). *Izv. Vyssh. Uchebn. Zaved., Radiofiz.;* **18**: No. 1, 5-16(Jan 1975). (In Russian).

14 refs.; 3 figs.; for English translation see the journnal Radiophys. Quantum Electron.

Kinetic instability of cyclotron waves in a two-component medium, consisting of a weakly-anisotropic equilibrium plasma and a discharged component with electrons, non-equilibrium of transverse is considered. The criteria of instability, wave increments momenta and investigations of their dependence on plasma and wave parameters have been obtained. It is shown that the best amplification is characteristic for cyclotron waves, which propagate perpendicularly to the magnetic field. The appearance of the kinetic instability in this region is due to the relativistic electron mass dependence on velocity.

42256 Investigations of low-frequency oscillations and ion acceleration in a plasma beam discharge. Demirkhanov, R.A.; Gevorkov, A.K.; Popov, A.F.; Kolmakov, O.A.; Astrakharchik, G.F. *Zh. Tekh. Fiz.;* **45**: No. 9, 1862-1868(Sep 1975). (In Russian).

11 refs.; for English translation see the journal Sov. Phys. - Tech. Phys.

Low-frequency oscillations in a beam-plasma discharge are investigated. It is shown experimentally that the excitation of low-frequency ion-acoustic and drift oscillations is related to the rapid heating of the electrons in the inhomogeneous plasma. A mechanism for the excitation of low-frequency oscillations is proposed. The acceleration of ions in the electric field of these oscillations is investigated.

42257 Plasma nonstationary turbulence while parametric resonance. Pustovalov, V.V.; Silin, V.P. (AN SSSR, Moscow. Fizicheskij Inst.). *Zh. Tekh. Fiz.;* **45**: No. 12, 2472-2478(Dec 1975). (In Russian).

12 refs.; for English translation see the journal Sov. Phys. - Tech. Phys.

Analysis of the nonlinear integrodifferential equation for the spectral energy density of longwave ion-acoustic waves subjected to stimulated scattering by ions reveals an oscillatory structure in the nonstationary turbulent state of a nonisothermal plasma; the turbulence is initiated by a parametric instability involving the decay of an intense electromagnetic wave into an electron plasma wave and an acoustic wave. The stability of the stationary turbulent of a parametrically excited plasma, studied previously, is demonstrated. The period of the oscillations in the anomalous-absorption coefficient for absorption of intense radiation by a plasma near the critical density is found. A numerical estimate of this period is given for the case of a laser-produced plasma.

42258 Experimental and theoretical study of the propagation of high amplitude pulses in a bounded magneto-plasma. Kunhardt, E.E. Brooklyn; Polytechnic Inst. of Brooklyn (1976). 123p. University Microfilms Order No. 76-23,421.

Thesis (Ph. D.).

Experiments on the propagation of narrow, high amplitude pulses along a plasma column have been conducted. The evolution of the pulse in space-time has been observed as a function of initial pulse strength. This technique gives insight into the competitive effects due to dispersion and nonlinearities. For a plasma, the positive column of a hot cathode, D.C. discharge in Argon is used. The pressure varied from 1 to 10m Torr Hg, and the averaged electron densities are of the order of 10^9—10^{10} cm^{-3}. The pulses for excitation are generated by a device capable of producing subnanosecond pulses with 3200 volts peak amplitude, into a 50 Ω line, at a repetitive rate of approximately 100 p.p.s.

42259 Parametric excitation of surface waves by modulated electric HF field. Demchenko, V.V.; Omel'chenko, A.Ya. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). *Ukr. Fiz. Zh. (Russ. Ed.);* **21**: No. 8, 1330-1338(Aug 1976). (In Russian).

For English translation see the journal Ukr. Phys. J.; published in summary form only.

42260 Excitation of electromagnetic waves in the range of plasma resonance in inhomogeneous plasma by nonlinear langmuir oscillations. Grishaev, V.I.; Demchenko, V.V. (Khar'kovskij Gosudarstvennyj Univ. (Ukrainian SSR)). *Ukr. Fiz. Zh. (Russ. Ed.);* **21**: No. 8, 1345-1354(Aug 1976). (In Russian).

For English translation see the journal Ukr. Phys. J.

Strongly nonlinear free electron oscillations were studied in a cold isotropic inhomogeneous plasma. The analytical expressions describing evolution of velocity and density of plasma electrons and strength of selfconsistent electric field in a time are obtained in the Lagrange variables. Cases of strong and weak spatial inhomogeneity of plasma which are of practical interest (plasma inhomogeneity parameter epsilon is the ratio of the amplitude of electron displacement from an equilibrium position towards the characteristic length of the plasma density inhomogeneity) are studied. It is shown that in the plasma resonance range the plasma inhomogeneity leads to parametric excitation of fast electromagnetic waves by the nonlinear Langmuir oscillations. The growth rate of the transverse waves equals by the order of value to electron plasma frequency multiplied by epsilon.

42261 'Enlightement' of a wave barrier under conditions of parametric instability of a pre-barrier plasma. Romanyuk, L.I.; Ustalov, V.V. (AN Ukrainskoj SSR, Kiev. Inst. Yadernykh Issledovanij). *Ukr. Fiz. Zh. (Russ. Ed.);* **21**: No. 8, 1389-1392(Aug 1976). (In Russian).

Letter-to-the-editor; for English translation see the journal Ukr. Phys. J.

42262 Damping and dispersion of linear longitudinal oscillations in a multi-component plasma. Lambert, A.J.D.; Sluijter, F.W.; Schram, D.C. (Technische Hogeschool Eindhoven (Netherlands)). *Physica, B, C;* **84**: No. 3, 394-400(Oct 1976).

This paper discusses linear dispersion and damping phenomena in multi-component Vlasov-Poisson plasma's without drift. The contamination damping is evaluated. The influence of temperature ratio, composition and mass ratio is discussed.

42263 Parametric decay of whistler waves. Turner, J.G.; Boyd, T.J.M. (Polytechnic of Central London (UK)). *Phys. Scr.;* **14**: No. 4, 175-178(Oct 1976).

The Lagrangian approach to non-linear wave interactions is applied to study the parametric decay of whistlers. These waves may decay into either an electron plasma wave together with an ion-acoustic wave or into a backward propagating whistler and an ion-acoustic wave. Growth rates and thresholds are obtained and compared with observed values.

42264 Propagation of ion acoustic solitons in a warm ion plasma. Tran, M.Q.; Hollenstein, C. (Ecole Polytechnique Federale, Lausanne (Switzerland)). *Helv. Phys. Acta;* **49**: No. 5, 764(29 Oct 1976).

From Swiss Physical Society spring meeting; Bern, Switzerland (8 - 9 Apr 1976).

Published in summary form only.

42265 Propagation of ion acoustic solitons in a two component plasma. Tran, M.Q.; Hollenstein, C. (Ecole Polytechnique Federale, Lausanne (Switzerland)). *Helv. Phys. Acta;* **49**: No. 5, 764-765(29 Oct 1976).

From Swiss Physical Society spring meeting; Bern, Switzerland (8 - 9 Apr 1976).

Published in summary form only.

42266 Model of excitation of an acoustic wave by the 'double plasma' mechanism. Weibel, E.S.; Tran, M.Q. (Ecole Polytechnique Federale, Lausanne (Switzerland)). *Helv. Phys. Acta;* **49**: No. 5, 764(29 Oct 1976). (In French).

From Swiss Physical Society spring meeting; Bern, Switzerland (8 - 9 Apr 1976).

Published in summary form only.

42267 Non-linear mixing of dispersive waves. Sato, N.; Maerk, E.; Popa, G. (Innsbruck Univ. (Austria). Inst. fuer Theoretische Physik). *Plasma Phys.;* **18**: No. 12, 897-904(Dec 1976).

Non-linear mixing of waves in dispersive media (including also non-dispersive media) is treated by using a simple model. The theory predicts some interesting features of harmonic wave propagation. The result can be applied to any dispersive wave with damping. The observed harmonic wave propagation of electron plasma waves is discussed on the basis of the non-linear mixing.

42268 Generation of plasma waves by Gaussian laser beam and stimulated Raman scattering. Sodha, M.S. (Drexel Univ., Philadelphia, Pa. (USA)); Sharma, R.P.; Kaushik, S.C. *Plasma Phys.;* **18**: No. 12, 879-888(Dec 1976).

An investigation of the generation of plasma waves at twice the pump wave frequency in a hot collisionless plasma by Gaussian laser beams is presented. On account of Gaussian intensity distribution of the laser beam a time independent component of ponderomotive force becomes finite in a direction transverse to the beam propagation. This causes redistribution of the carriers and the beam gets self-focused. Intensity of the generated plasma waves is found to be further enhanced due to self-focusing of the pump wave. Stimulated Raman scattering from these excited plasma waves is also enhanced.

42269 RF coupling and mode conversions at the lower hybrid resonance. Wong, K.C. (Massachusetts Univ., Amherst (USA)); Tang, T.W. *Plasma Phys.;* **18**: No. 12, 911-928(Dec 1976).

A thorough analytical study is conducted of linear mode conversion near lower hybrid resonance in a one-dimensional weakly inhomogeneous plasma. The analysis is based on the cold-, warm- and hot-plasma approximations depending on the ratio of the ion Larmor radius to the perpendicular wavelength. Mode conversion is found to take place in two different locations. An appropriate differential equation is derived to describe the electric field in each of the mode conversion regions. A complete conversion of a long wavelength mode to a short wavelength mode is confirmed in both regions. The energy coupled into the plasma and the surface impedance of the plasma are computed for slow-wave excitations.

42270 Propagation characteristics of cold lower hybrid waves in linear tokamak plasmas. Tanaka, S.; Nishitani, S.; Fukushima, M.; Terumichi, Y. (Kyoto Univ. (Japan). Dept. of Physics). *Phys. Lett., A;* **59**: No. 4, 290-292(13 Dec 1976).

Propagation of the cold lower hybrid waves in cylindrical tokamak plasmas is studied theoretically. The energy flow trajectory is spiral in the poloidal direction and along the toroidal direction, as

well. The latter distance to the resonance layer is equal to $\sqrt{M}/ma$, in order (a: radius of plasma column).

FUSION POWER PLANTS

42271 (AED-Conf—76-506-007) **Experiments on JIPP T-II, a hybrid system of stellarator and Tokamak.** Fujita, J.; Fujiwara, M.; Hamada, Y.; Itoh, S.; Kadota, K.; Kawahata, K.; Kuroda, T.; Matsuoka, K.; Matsuura, K.; Miyahara, A. (Nagoya Univ. (Japan). Inst. of Plasma Physics). 1976. 5p. (IAEA-CN—35/D-3; CONF-761012—73). Dep. NTIS (US Sales Only), PC A02/MF A01.

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, German, Federal Republic of (F.R. Germany) (6 Oct 1976).

5 figs.; 1 tab.; 5 refs. Available from the IAEA.

The experiment on feedback control of the plasma position in resistive shell configuration is carried out on JIPP T-II; the vertical magnetic field is feedback-controlled and the horizontal one is preprogrammed. A stable Tokamak plasma can be successfully obtained by feedback control of the vertical magnetic displacement of plasma ring is suppressed within a certain value by the pre-programmed horizontal field. When the safety factor qsub(α) estimated on the plasma boundary decreases less than 3 in a high current discharge, the current disruption occurs with negative voltage spikes of several tens of volts. When the safety factor qsub(α) is kept larger than 3 during the discharge by the adjustments of the plasma current and position, the current duration reaches twenty times as large as the skin time (tausub(s) = 5.3 msec) of the resistive shell.

42272 (BNWL—2139) **Performance targets for fusion-fission (hybrid) reactors.** Deonigi, D.E.; Engel, R.L. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jan 1977. Contract EY-76-C-06-1830. 70p. Dep. NTIS, PC A04/MF A01.

The potential roles for various performance levels of hybrid power plants in the United States have been estimated for various scenarios which describe the systems with which the hybrid plants must compete. Due to the uncertainty in estimating the costs of hybrid power plants, a parametric approach was chosen to identify acceptable characteristics and associated tradeoffs. Because hybrid power plants produce substantial quantities of both plutonium and electricity, a simulation model is necessary which appropriately values each of these products. This would permit design tradeoffs and realistic interactions with other generating plants, such as Liquid Metal Fast Breeder Reactors (LMFBRs) and Light Water Reactors (LWRs), to be estimated. A linear programming model nearly identical to that used for the recent LMFBR cost-benefit analysis was utilized for this purpose.

42273 (COO—2456-41) **Columbia Torus II design report.** (Columbia Univ., New York (USA). Plasma Physics Research Lab.). Jan 1977. Contract EY-76-S-02-2456.A001. 20p. Dep. NTIS, PC A02/MF A01.

Torus II was designed to generate a hot (greater than or equal to 100 eV) plasma for purposes of doing research on high-beta MHD stability and equilibrium problems in axisymmetric toroidal geometry. Programming of the Torus II fields is shown. The sequence of events can be divided into (a) preionization phase, (b) preheating phase, and (c) hot, high-beta tokamak phase. Some mechanical and electrical design features are described. The capacitor bank system is also described. (MOW)

42274 **Prospects and technical problems of nuclear fusion.** Alexander, K.F. (Akademie der Wissenschaften der DDR, Berlin. Zentralinstitut fuer Elektronenphysik). *Energietechnik;* **26**: No. 5, 189-193(May 1976). (In German).

From 7. Meeting on power plant engineering; Dresden, German Democratic Republic (30 Sep 1975).

Stressing the Tokamak principle both the prospects and technical problems of using controlled nuclear fusion for power generation are dealt with. The physical fundamentals of plasma generation from light nuclei are discussed including the possibilities of confining and producing fusion plasma as well as principles and geometries of plasma containment. Finally, development stages of fusion reactor designing and advantages of such reactors in comparison to nuclear fission reactors, e.g., breeder reactors, are estimated.

42275 (JAERI-M—6359) **Annual report of the Division of Thermonuclear Fusion Research, JAERI. Covering the period of April 1, 1974 to March 31, 1975.** (Japan Atomic Energy Research Inst., Tokyo). Jan 1976. 163p. Dep. NTIS (US Sales Only), PC A08/MF A01.

Works performed in the Division of Thermonuclear Fusion Research for the period of April 1974 to March 1975 are described. (1) In JFT-2, power-up work of the generator to increase the toroidal magnetic field from 10 kG to 18 kG was completed in October 1974, and the JFT-2 phase-II experiment started. (2) A JFT-2a tokamak of a tear-drop cross-section with axisymmetric divertor was put into operation in August 1974, as scheduled. Initial experiments confirmed that the plasma enclosed inside a separatrix magnetic surface was stably produced. (3) In the diagnostics, a data processing system and a multi-channel particle analyzer were fabricated and put into operation. (4) A test stand (ITS-1) for the development of neutral beam injectors was assembled, and the preliminary experiment on an ion source started in February 1975. (5) In design study of a large tokamak device JT-60, the preliminary design was completed under contract with the industry. Physical studies on the plasma confinement in JT-60 and refinement and improvement of the design continued. (6) Theoretical and computational works continued in neutral injection heating, impurity transport, relaxation of radial electric field and mhd stability. (7) The design of a 2000 MW fusion power reactor which started in the previous year was further improved. The concept and design criteria of an experimental power reactor were studied.

42276 (JAERI-M—6484) **Basic plasma parameters of an experimental fusion reactor. First preliminary design.** Yamato, H.; Tone, T.; Sako, K. (Japan Atomic Energy Research Inst., Tokyo). Mar 1976. 26p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

Basic plasma parameters are determined for the first preliminary design of a tokamak experimental reactor. Three scaling laws, i.e., the pseudoclassical diffusion, neo-Bohm diffusion and anomalous loss due to the trapped ion mode are taken into consideration. Values of the plasma are calculated, varying the power output (100 -- 500MW), spatial maximum of toroidal field (8 -- 14T), aspect ratio (3 -- 6) and safety factor (1.5 -- 3.5) while the plasma temperature and the poloidal β are constant at 7 keV and 2 respectively. The following design parameters are finally chosen: the power output 100MW, toroidal field on the plasma axis 6T, aspect ratio 4.5 and major radius 6.75m.

42277 (LASL—77-3) **Toroidal Z-pinch demonstration.** Burkhardt, L.C. (Los Alamos Scientific Lab., N.Mex. (USA)). Mar 1977. Contract W-7405-ENG-36. 4p. Dep. NTIS, PC A02/MF A01.

A brief elementary description of a toroidal z-pinch is given. A brief review of pinch research at LASL is also presented. (MOW)

42278 (ORNL—5278) **Conclusions from the Oak Ridge EPR studies and initiation of the TNS program. A brief summary.** Roberts, M. (Oak Ridge National Lab., Tenn. (USA)). Mar 1977. Contract W-7405-ENG-26. 22p. Dep. NTIS, PC A03/MF A01.

This ORNL study has resulted in an evaluated reference design that does satisfy the technical objectives set out for a Tokamak Experimental Power Reactor (EPR). Because of this design's large size, high cost, and poor extrapolation to a demonstration reactor, the basic physics and range of technical objectives have been reconsidered. This has led to an intermediate step and new design, The Next Step (TNS) after TFTR, having a higher benefit/cost than EPR. The TNS program, now in the early design phases, is focused on a device with smaller size and considerably higher power output than the EPR design. This device's improved performance is made possible by a projection of operation at higher plasma density than that assumed for EPR. This more optimistic plasma performance projection is based on a reexamination of basic physics assumptions and of current plasma physics experiments; a focused experimental and theoretical effort will be required in the near future to validate this projection. With this improved performance, the TNS designs can be extrapolated to an economically viable fusion reactor.

42279 (UCID—17404) **Beam-plasma instability in ion beam systems used in neutral beam generation.** Hooper, E.B. Jr. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Feb 1977. Contract W-7405-ENG-48. 12p. Dep. NTIS, PC A02/MF A01.

The beam-plasma instability is analyzed for the ion beams used for neutral beam generation. Both positive and negative ion beams are considered. Stability is predicted when the beam velocity is less than the electron thermal velocity; the only exception occurs when the electron density accompanying a negative ion beam is less than the ion density by nearly the ratio of electron to ion masses. For cases in which the beam velocity is greater than the electron thermal velocity, instability is predicted near the electron plasma frequency.

42280 **Fusion reactor and operating process.** Lubin, M.J. (to USAEC Directorate of Licensing). French Patent 2,296,917/A/. 6 Jan 1975. 14p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

The process described is to operate a thermonuclear reactor comprising the dispatch of hot liquid lithium at a tangent into a pressure vessel from a heat exchanger and then sending this lithium from the vessel to the heat exchanger so as to form a hollow central area in the pressure vessel. The periodical injection of individual congelled thermonuclear fuel pellets into this cavity area and the sending of a laser beam into this cavity along the injection path of the fuel pellets bring about fusion reactions in the pellets and cause the fast neutrons resulting from the reactions to produce tritium in

the liquid lithium inside the pressure vessel. The tritium is removed in the heat exchanger and the heat extracted in the heat exchanger is used to work a steam turbine to generate electricity.

42281 Concept of a fusion burner. Hasegawa, A. (Bell Labs., Murray Hill, N.J. (USA); Nagoya Univ. (Japan). Inst. of Plasma Physics); Hatori, T. (Nagoya Univ. (Japan). Inst. of Plasma Physics); Itoh, K. (Tokyo Univ. (Japan). Dept. of Physics); Ikuta, T.; Kodama, Y.; Nozaki, K. (Nagoya Univ. (Japan). Dept. of Physics). *Nucl. Fusion;* **16**: No. 5, 865-866(1976).

Letter-to-the editor.

42282 Review of the conceptual design of a Doublet fusion experimental power reactor. Baker, C.C. (Gen At Co, San Diego, Calif). *Am. Soc. Mech. Eng., [Pap.];* No. 76-WA/NE-9, 1-8(5 Dec 1976).

The results of a two-year, conceptual design study of a fusion experimental power reactor (EPR) are presented. For this study, the primary objectives of the EPR are to obtain plasma ignition conditions and produce net electrical power. The design features a Doublet plasma configuration with a major radius of 4.5 m. The average plasma beta is 10 percent which yields a thermonuclear power level of 410 MW during a 105-sec burn period. With a duty factor of 0.84, the gross electrical output is 124 MW(e) while the net output is 37 MW(e). The design features a 25-cm-thick, helium-cooled, modular, stainless-steel blanket with a 1-cm-thick, silicon carbide first wall. Sufficient shielding is provided to permit contact maintenance outside the shield envelope within 24 hr after shutdown. An overall plant concept has been developed including a superheated steam cycle power conversion system. Preliminary cost estimates and construction schedules have also been developed. 3 refs.

42283 Experiments towards a toroidal-theta-pinch fusion reactor. Krakowski, R.A.; Quinn, W.E.; Ribe, F.L.; Thomas, K.S. (Los Alamos Scientific Lab., N.Mex. (USA)). *Nucl. Eng. Int.;* **22**: No. 253, 45-51(Feb 1977).

A description is given of Scyllac, a high beta stellarator experiment designed to study several plasma instability problems associated with a theta-pinch configuration. The particular problem occurring when the torus variation is employed and the solutions to these problems which led to a conceptual design of a toroidal theta-pinch fusion reactor are discussed. Details are given of staged theta-pinch experiments and of the reference theta-pinch reactor (RTPR).

42284 Doublet fusion programme - one step from electricity production. Prater, R. (General Atomic Co., San Diego, Calif. (USA)). *Nucl. Eng. Int.;* **22**: No. 253, 42-45(Feb 1977).

Doublet III, the first tokamak designed to generate and maintain the plasma conditions required for a reactor, is described. Stages in its development are outlined with parameters for past, present, and planned devices of General Atomics experimental fusion research programme. Information from the first three machines Doublet I, Doublet II and Doublet IIA helped the design of Doublet III. The Experimental Power Reactor-1 (EPR-1) is a design study showing what a Doublet-powered plant would consist of, based on the present knowledge of plasma scaling, whilst the final facility planned, the Demonstration Power Reactor (DPR), is a scaled-up version of the EPR demonstrating the major features of a larger commercial fusion power plant.

PHYSICS AND BLANKET ENGINEERING

REFER ALSO TO CITATION(S) 42200

42285 (JAERI-M—6453) **Preliminary study on power balance in the plasma of an experimental fusion reactor.** Tone, T.; Yamato, H. (Japan Atomic Energy Research Inst., Tokyo). Mar 1976. 40p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

The preliminary study on power balance in the plasma is described in the first-stage design of an experimental fusion reactor. The purpose is to show the ranges of plasma parameters for the design output of about 100 MW with an injection power less than 50 MW. The impurity is permitted to the extent of Zsub(eff) -- 5 to meet the design requirement. Influences of the uncertainty in scaling law on the power output and injection power are discussed, and also possibility of the self-ignition.

42286 (JAERI-M—6475) **Evaluation of neutron streaming through injection ports in a tokamak-type fusion reactor.** Ide, T.; Seki, Y.; Iida, H. (Japan Atomic Energy Research Inst., Tokyo). Mar 1976. 18p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The effects of neutron streaming through injection ports in the fusion reactor designed in JAERI have been studied, especially those on tritium breeding ratio and the shielding of the superconducting magnet. In placement of the injection ports in the blanket, the tritium breeding ratio decreases by up to 1.3%, and shielding problem of the superconducting magnet is very important.

42287 (JAERI-M—6495) **Preliminary results of integral experiment on fusion-fission hybrid blanket assemblies.** Maekawa, H.; Seki, Y. (Japan Atomic Energy Research Inst., Tokyo). Mar 1976. 11p. Dep. NTIS (US Sales Only), PC A02/MF A01.

To study neutronics in the fusion-fission hybrid reactor blanket, two types of spherical hybrid assembly, i.e. with and without a graphite reflector, were prepared by piling up lithium, natural uranium and graphite blocks. Effective outer radii of the central cavity, natural uranium, lithium metal and graphite regions are 3.3, 10.0, 34.1 and 55.3 cm, respectively. In the assembly without a graphite reflector, the forms of measured fission rate distribution are in good agreement with those by calculation; however, there is large difference between the measured and the calculated fission ratios ($^{238}U/^{235}U$). In the assembly with it, the measured fission ratio is in good agreement with the calculated one, except in the graphite region. The measured neutron multiplication factor due to the natural uranium is about 2.5, in agreement with the calculated one.

42288 Synchrotron radiation of runaway electrons in the TM-3 TOKAMAC. Vlasenkov, V.S.; Larionov, M.M.; Rozhdestvenskii, V.V. (AN SSSR, Leningrad. Fiziko-Tekhnicheskij Inst.). *Zh. Tekh. Fiz.;* **45**: No. 12, 2521-2525(Dec 1975). (In Russian).

For English translation see the journal Sov. Phys. - Tech. phys.

Measurements of the radiation temperature at 4 and 8mm from the plasma in the Tokamak TM-3 are presented. Radiation temperatures up to 10 keV, which is higher than the plasma temperature, are observed. This effect is attributed to synchrotron radiation from runaway electrons. The properties of this radiation are investigated. The radiation measurements are used to determine the parameters of the runaway electrons. Investigation of the plasma microwave radiation is a possible diagnostic means for obtaining information about the electron component of the plasma. By using the radiation temperature and the emission spectrum, it is sometimes possible to determine the electron temperature and density: In other cases it is possible to obtain information on deviations of the electron distribution function from equilibrium and on the presence of high-frequency oscillations in the plasma.

42289 Fissile fuel breeding potential with paired fusion-fission reactors. Harms, A.A.; Gordon, C.W. (McMaster Univ., Hamilton, Ontario (Canada)). *Ann. Nucl. Energy;* **3**: No. 9, p. 411-420(1976).

The potential fissile fuel breeding capacity of paired fusion-fission reactors is examined. Compact relationships for the fissile fuel conversion ratio and fissile doubling time are derived as functions of both fusion and fission reactor parameters for two operational cases. Based on this lumped parameter analysis, it is concluded that substantial fissile fuel production with paired fusion-fission nuclear energy systems is thus possible.

42290 Calculations of the neutron emission spectra from materials bombarded with 14-mev neutrons. Hansen, L.F.; Grimes, S.M.; Howerton, R.J.; Anderson, J.D. (Lawrence Livermore Lab, Calif). *Nucl. Sci. Eng.;* **61**: No. 2, 201-211(Oct 1976).

Neutron emission spectra from targets bombarded by 14-MeV neutrons have been calculated using three nuclear models. The elements studied included aluminum, iron, copper, nickel, and niobium and were selected because of their potential importance in fusion reactor design and because measured cross-sections and evaluated cross-section libraries were available for comparison with the calculations. Contributions from statistical, pre-equilibrium, and direct reactions are included to achieve a good fit to the data. The calculated spectra are also compared with the predictions of the ENDF/B-IV and the Livermore ENDL neutron libraries.

42291 ORNL-EPR study--results and implications. Mcalees, D.G. (Exxon Nucl Co, Oak Ridge, Tenn). *Am. Soc. Mech. Eng., [Pap.];* No. 76-WA/NE-10, 1-8(5 Dec 1976).

A two-year preliminary design study of a tokamak experimental power reactor has been completed by the Oak Ridge National Laboratory. The major engineering features, plasma physics characteristics, and technological requirements of the device are discussed. 14 refs.

MAGNET COILS AND FIELDS

42292 (JAERI-M—6451) **Optimum design of the poloidal field coils of a large fusion device.** Kobayashi, T.; Tani, K.; Takeda, T.; Kobayashi, T.; Shimada, R. (Japan Atomic Energy Research Inst., Tokyo). Mar 1976. 62p. (In Japanese). Dep. NTIS (US Sales Only), PC A04/MF A01.

A numerical method to determine optimum configuration of the poloidal field coils of a large tokamak is described. A simplex method of non-linear programming is used for optimization calculation. To meet various requirements in design of the tokamak, the optimization procedure in an arbitrary area in the two-dimensional space is developed. It is also applicable to the case where the relative position of a specific group of coils must be fixed in a given area.

42293 (JAERI-M—6470) **Computer code for study of the error magnetic fields based on a model of practical poloidal field coils in a large tokamak.** Yoshida, Y.; Saito, R.; Seki, S.; Kitsunezaki, A.; Kobayashi, T. (Japan Atomic Energy Research Inst., Tokyo). Mar 1976. 14p. (In Japanese). Dep. NTIS (US Sales Only), PC A02/MF A01.

A computer code has been prepared for study of the error magnetic fields due to poloidal field coils in a large tokamak. It is based on the model of a practical structure of the windings by segmented multicurrent filaments in three-dimensional space.

42294 (N—76-25020) **Stress distributions of coils for toroidal magnetic field.** Kajita, T.; Miyamoto, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Mar 1976. 31p. (IPPJ-T—24). NTIS $4.00.

The stress distributions of D shape coils and circular coils are computed by a finite element method. The dependence of the stress distribution on the geometrical parameters of the coils and supporting methods are examined. The maximum amount of the stress of D shape coils is not much smaller than that of circular coils. However the stress distribution of D shape coils becomes much more uniform. The supporting method is as influential as the geometrical parameters of the coils on the stress distribution. (Author) (GRA)

42295 (N—76-25023) **Linked min.B configuration inside high shear magnetic surface.** Ohasa, K.; Ikuta, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Mar 1976. 21p. (IPPJ—241). NTIS $3.50.

Arrangement of the baseball coils to form the toroidally linked minimum B configuration with large rotational transform is studied analytically and numerically for $l=m$. By an optimization the closed magnetic isobars are obtained inside the last closed magnetic surface having practical volume and high shear if baseball coils are arranged for $l=3$.

42296 (ORNL/MIT—242) **Design of cryogenic heat exchangers for a superconducting magnet.** Chrusciel, W.A.; Tao, B.Y.; Ventura, S.A. (Massachusetts Inst. of Tech., Oak Ridge, Tenn. (USA). School of Chemical Engineering Practice). 26 Oct 1976. Contract W-7405-ENG-26. 56p. Dep. NTIS, PC A04/MF A01.

Computer programs were written to design and simulate the behavior of three heat exchangers for cooling supercritical helium to approximately 4.3°K at 4 atm. Helium, at 1, 3, or 5 gm/sec, is cooled by passing it through 0.635-cm-diam copper tubing immersed in a liquid nitrogen bath, through a copper, concentric tube, countercurrent heat exchanger, and then through 0.635-cm copper tubing immersed in a liquid helium bath. The helium then enters a superconducting test magnet and finally passes through the annulus of the countercurrent exchanger before venting to the atmosphere. Several acceptable designs are presented that meet design and space limitations.

42297 **Full-size vacuum vessel and helical winding for the W VII Stellarator.** Duesing, G.; Freudenberger, K.; Kolos, J.; Streibl, B.; Wulff, G. (Euratom Association, Garching, Ger.). pp 768-772 of In Sixth symposium on engineering problems of fusion research. New York; Institute of Electrical and Electronics Engineers, Inc. (1976).

From 6. symposium on engineering problems of fusion research; Chicago, IL, USA (1975).

The design of the toroidal vacuum vessel and the helical winding of the Wendelstein VII B stellarator has been completed. The electromagnetic forces acting on the winding have called for a support structure assembled from a thick-walled torus upon which the conductors are wound and forty structure groups around this. The rigid compound structure limits the critical stresses in the helical conductors and at the junction of the torus and its removable segment. Thermal stresses arising in the conductors and the torus wall are limited by water-cooling. The complex manufacturing procedure requires expertise in many different techniques.

42298 **Dynamic constraints on inductive energy storage.** Schmitter, K.H. (Max-Planck Institut fuer Plasmaphysik, Garching, Ger.). pp 296-298 of In Sixth symposium on engineering problems of fusion research. New York; Institute of Electrical and Electronics Engineers, Inc. (1976).

Relations between energy density and discharge rate in inductive energy storage units are considered. The dynamic constraints imposed on the unit size are estimated for the Brooks coil geometry.

POWER SUPPLIES AND CIRCUITRY

42299 **Magnetic energy storage system used in ZT-1.** Burkhardt, L.C.; Dike, R.; Di Marco, J.N.; Phillips, J.A.; Haarman, R.; Schofield, A.E. (Los Alamos Scientific Lab., NM). pp 351-354 of In Energy storage, compression, and switching. Bostick, W.H. (ed.). New York; Plenum Publishing Corp. (1976).

The ZT-1 toroidal pinch experiment is driven by a magnetic energy storage system that uses four fuses to interrupt the current. One fuse package can interrupt 800 kA, develop 70 kV peak, and absorb 30 kJ. Each quadrant is driven by a fuse to increase the total voltage around the torus to 280 kV and the total inductively stored energy is 100 kJ. Approximately 10% agreement is obtained with a numerical calculation used to predict the fuse behavior. Inductive coupling of 14 nH between the four fuses eliminates the jitter of ~ 0.1 μs, observed with a single fuse.

42300 **Results of experiments with a superconductive prototype coil for a toroidal magnet.** Pillsticker, M.; Krueger, P. (Max-Planck Institut fuer Plasmaphysik, Garching, Ger.). pp 610-614 of In Sixth symposium on engineering problems of fusion research. New York; Institute of Electrical and Electronics Engineers, Inc. (1976).

A superconductive prototype coil originally concepted as one of 40 elements for inducing a toroidal magnetic field was tested. The technical concept of the coil is reported. A quench current of 97.5 percent of the critical short sample value was measured. Then the stored energy is 2.11 MJ. The winding is screened for reducing transient magnetic fields at the superconductor. A magnetic field with a rise time of nearly 5 ms and a magnitude of 0.5 T at the windings in the unscreened state results in the drop down of the quench current of about 13 percent. This quench was caused by the magnetic field and not by warming up the winding affected by the dissipated energy of the magnetic pulse in the helium cooled electrical damping screen. The cryogenic losses of the coil cryostat are 20 to 33 W depending on the operating conditions.

FUEL SYSTEMS

REFER ALSO TO CITATION(S) 41147, 41148, 41149, 41150, 41151, 41153

42301 (AED-Conf—76-506-003) **Filling of toroidal traps with laser plasmas.** Spalding, I.J.; Armandillo, E.; Donaldson, T.P.; Kachen, G.I.; Walker, A.C.; Ward, S. (UKAEA Research Group, Abingdon. Culham Lab.). 1976. 6p. (IAEA-CN—35/G3-3; CONF-761012—75). Dep. NTIS (US Sales Only), PC A02/MF A01.

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, German, Federal Republic of (F.R. Germany) (6 Oct 1976).

4 refs.; 23 refs. Available from the IAEA.

New results have been obtained in generating energetic CO_2 laser pulses of variable duration and in related heating investigations for the single-target laser-plasma filling of toroidal magnetic traps. Pulses of order 1 kJ have been reliably produced on the time scales of interest. keV plasmas are readily produced at lower energies, and at intensities $<= 10^{13}$ Wcm^{-2}; the plane-target absorption efficiency is high despite the long wavelength, because of non-classical effects which are investigated experimentally. Factors affecting the coupling efficiency to smaller low anti Z targets are also discussed.

42302 (BNL—22436) **Neutral beam injector research and development work in the USA.** (Oak Ridge National Lab., Tenn. (USA); California Univ., Berkeley (USA). Lawrence Berkeley Lab.; California Univ., Livermore (USA). Lawrence Livermore Lab.; Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract EY-76-C-02-0016. 7p. (CONF-761012—45; IAEA-CN—35/15). Dep. NTIS, PC A02/MF A01.

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, German, Federal Republic of (F.R. Germany) (6 Oct 1976).

Neutral beam injection research and development at Brookhaven National Laboratory, Lawrence Berkeley and Livermore Laboratories, and Oak Ridge National Laboratory is described. The ORNL Neutral Beam Development Program is concentrated on the development and application of tokamak neutral beam injection systems. Tokamak neutral beam development is being carried out for ORMAK, PLT, ORMAK-Upgrade, PDX and TFTR. Applications have been made to ORMAK and are being made to PLT. Basic research in support of the development program includes work in the areas of plasma sources, ion extraction and beam optics, cryopumping, beam stops and megawatt electrical power systems. The LBL/LLL Neutral Beam Development Program can be divided into two areas: (1) development based on positive-ion acceleration and neutralization, primarily for near-term applications on the 2X, BB, MX, and TFTR confinement experiments, and (2) a higher-efficiency-injector program based on acceleration and neutralization of negative ions, which may be required for fusion reactors and reactor-like experiments. The objective of the BNL Neutral Beam Program is to develop a 150 keV multiampere (equivalent) neutral injector with essential support systems based on long pulse, multiampere sources of negative hydrogen and deuterium ions, close coupled acceleration to the required energy and on neutralization of high energy negative ions in a gas or plasma jet. High speed cryogenic and molecular sieve pumps are being developed as part of the program.

42303 (JAERI-M—6467) **Power supply to the air-core transformer coils of a large tokamak by a multi-stage inductive energy storage system. Optimal design of the electric circuits by a simplex method.** Tani, K.; Kobayashi, T.; Tazima, T.; Takeda, T.; Shimada,

R. (Japan Atomic Energy Research Inst., Tokyo). Mar 1976. 32p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

The multi-stage inductive energy storage circuits have been studied by a simplex method to obtain an optimum design of a power supply system for the air-core transformer coils of a large tokamak. Parameters of the electric circuits subject to various constraints were determined by the method. The multi-stage inductive energy storage system is better than the single-stage system in viewpoint of the energy necessary to build up the plasma current. Circuit analysis including the plasma was made for the two cases: (1) the plasma resistance given as a function of time, and (2) the plasma resistance determined from a zero-dimensional plasma model. The plasma self-inductance and its time variation play an important role during the build up of plasma current, and influence largely on the optimal circuit parameters.

42304 **Container for fusion fuel.** Nolen, R.L. Jr.; Solomon, D.E. (to KMS Fusion, Inc). German(FRG) Patent 2,548,446/A/. 26 May 1976. 13p. (In German).

2 figs.

A pellet, consisting of a hollow sphere filled with one or more hydrogen isotopes and whose shell is composed of two layers, is proposed for use as fusion fuel to be irradiated by a laser beam. The inner shell (thickness 0.3 to 1.5 nm) consists of carbon, the layer on it of a gas-permeable material with an atomic number between 10 and 103; its thickness is 100 to 1,000 nm. Palladium, platinum, nickel, copper and SiO_2 are named as suitable materials. The pellet is filled by diffusion; it has better mechanical properties than glass pellets.

INERTIAL CONFINEMENT SYSTEMS

REFER ALSO TO CITATION(S) 41147, 41149, 41902, 42221

42305 (AD-A—034450) **Efficient laser light absorption by ion acoustic fluctuations. Interim report.** Manheimer, W.M.; Colombant, D.G.; Ripin, B.H. (Naval Research Lab., Washington, D.C. (USA)). Dec 1976. 11p. (NRL-MR—3426). NTIS, PC A02/MF A01.

A new efficient absorption mechanism for intense laser light in plasma resulting from an ion acoustic instability generated by a return current is described. Comparisons with experimental results are presented.

42306 (JEN—351) **Influence of laser design parameters on the hydrodynamics of microfusion plasmas.** Sanmartin, J.R.; Barrero, A. (Junta de Energia Nuclear, Madrid (Spain)). 1976. 67p. (In Spanish). Dep. NTIS (US Sales Only), PC A04/MF A01.

The quasineutral, one-dimensional motion generated in a cold, infinite, uniform plasma of density n_0, by the absorption, in a given plane, of a linear pulse of energy per unit time and area phi - phi$_0$t/tau, $0<t=(<=)$tau, is considered; the analysis allows for thermal conduction and viscosity of ions and electrons, their energy exchange, and an electron thermal flux limiter. The motion is found to be selfsimilar and governed by a single nondimensional parameter α approximately $(n_0^2 tau/phi_0)^2/3$.)etailed asymptotic results are obtained for both $\alpha << 1$ and $\alpha << 1$; the general behaviour of the solution for arbitrary α is discused. The analysis can be easily extended to the case of a plasma initially occuping a half-space, and throws light on the hydrodynamics of laser fusion plasmas. Approximate results existing in the literature for constant irradiation (phi) of a plasma are recovered under appropiate limiting processes.

42307 (RL—76-147/B) **Fast optics for the Rutherford laser compression experiments.** Micholas, D.J.; Welford, W.T. (Science Research Council, Chilton (UK). Rutherford Lab.). Dec 1976. 12p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The compression chamber optical system proposed for the Rutherford Laboratory Laser compression experiments is described. The system corrects for longitudinal spherical aberration giving a final spot size approximately 15 μm. This could theoretically be improved. The two laser beams are focused via a pair of F/1.2 aspheric lenses onto a double-pass 'clam shell' aspheric mirror system. An analysis of the lens and mirror system is given and compared with an alternative ellipsoidal system already developed. The problems of manufacturing aspheric lenses to operate at 1.06 μm are outlined and an alternative novel approach to this design given.

42308 (UCRL—77943(Rev.2)) **Plasma experiments with 1.06-μm lasers at the Lawrence Livermore Laboratory.** Ahlstrom, H.G.; Holzrichter, J.F.; Manes, K.R.; Storm, E.K.; Boyle, M.J.; Brooks, K.M.; Haas, R.A.; Phillion, D.W.; Rupert, V.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 20 Dec 1976. Contract W-7405-ENG-48. 42p. (CONF-761155—3). Dep. NTIS, PC A03/MF A01.

From 4. workshop on laser interaction and related plasma phenomena; Troy, New York, United States of America (USA) (8 Nov 1976).

Recent laser fusion experiments at the Lawrence Livermore Laboratory have provided basic data concerning: laser beam propagation and absorption in high temperature plasmas, electron energy transport processes that transfer the absorbed laser energy to the high-density ablation region, the general fluid dynamic expansion and compression of the heated plasma, and the processes responsible for the production of 14-MeV neutrons during implosion experiments. Irradiation experiments were performed with Nd:YAG glass laser systems: the two-beam Janus (less than or equal to40 J/100 ps, ~0.4 TW) and Argus (less than or equal to140 J, 35 ps, ~4 TW), and the single beam Cyclops (less than or equal to70 J/100 ps, ~0.7 TW). Two classes of targets have been used: glass microshells (~40 to 120 μm in diameter with ~0.75-μm-thick walls) filled with an equimolar deuterium-tritium mixture, and disks (~160 to 600 μm in diameter and approx. 10 μm thick) of several compositions. The targets were supported in vacuum (pressure less than or equal to10^{-5} Torr) by thin glass stalks. This paper reports on results related to the propagation, absorption, and scattering of laser light by both spherical and planar targets.

42309 **Laser and controlled thermonuclear fusion--2.** Bobin, J.L. (CEA, Villeneuve-Saint-Georges, Fr). *Onde Electr.;* **56**: No. 8-9, 367-371(1976). (In French).

This paper deals with laser driven thermonuclear fusion schemes involving the spherical compression of targets. The basic parameters of such a problem are pointed out: final density, absorbed radiative flux, characteristic velocity. The dynamics of the process and the relevant efficiencies are investigated. Experiments on laser interaction with matter are reviewed in this connection. 30 refs.

42310 **Laser fusion and laser isotope separation overview.** McNally, J.H. (Energy Research and Development Administration, Washington, DC). *Ann. N.Y. Acad. Sci.;* **267**: 61-70(30 Jan 1976).

From 3. conference on the laser; New York, New York, USA (22 Apr 1975).

See CONF-750460—.

The principles of laser fusion are outlined. The current status of laser fusion technology is reviewed along with some program milestones. Funding effects on the program are briefly mentioned. (MOW)

42311 **Laser fusion at KMSI/KMSF.** Gomberg, H.J. (KMS Fusion, Inc., Ann Arbor, MI). *Ann. N.Y. Acad. Sci.;* **267**: 111-116(30 Jan 1976).

From 3. conference on the laser; New York, New York, USA (22 Apr 1975).

See CONF-750460—.

A review of the formation of KMS Industries is given. Some milestones achieved by KMSF are mentioned along with future plans for producing hydrogen and methane. (MOW)

42312 **Current status of laser fusion research at Battelle.** Mallozzi, P.J.; Epstein, H.M.; Jung, R.G.; Applebaum, D.C.; Fairand, B.P.; Gallagher, W.J.; Campbell, B.E. (Battelle Memorial Inst., Columbus, OH). *Ann. N.Y. Acad. Sci.;* **267**: 126-134(30 Jan 1976).

From 3. conference on the laser; New York, New York, USA (22 Apr 1975).

See CONF-750460—.

The central research discussed is the analysis and control of laser-produced high-Z plasmas. Research consisting mainly of laser development, model and code development, and target irradiations is described. Some medical applications of the research are also mentioned. (MOW)

42313 **Effect of wavelength on absorption and ionization of laser-produced plasmas in magnetic fields with allowance for finite rate ionization and recombination.** Lengyel, L.L. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). *Plasma Phys.;* **18**: No. 12, 929-945(Dec 1976).

Radiation absorption and bulk ionization efficiences are considered in a one-dimensional hydrodynamic approximation by taking finite-rate ionization and recombination processes into account. The magnetic field effect on the plasma motion is taken into account by assuming that the plasma remains diamagnetic during its spherical expansion phase. At the moderate laser flux intensities and associated corona temperatures considered classical absorption is the dominating energy transfer mechanism, and the shorter the wavelength the better are the attainable absorption and ionization efficiencies. However, even at anomalous absorption rates manifested by complete energy damping at the critical density, pellet thermalization and bulk ionization are found to be more efficient at shorter wavelengths. Neglecting the finite ionization and recombination rates may lead to errors in predicting the location of the cutoff electron density layer and of the obtainable bulk ionization degree. The formation of a high-density high-temperature plasma sheath with appreciable polarization across the sheath is shown to take place at the plasma cloud magnetic field interface. Methods for avoiding the v x B-induced drift motion associated with non-symmetric pellet irradiation are outlined.

COMPONENT DEVELOPMENT AND TESTING

REFER ALSO TO CITATION(S) 42298

42314 (ANL/FPP—76-6) **Fusion power program. Quarterly progress report, October—December 1976.** (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 78p. Dep. NTIS, PC A05/MF A01.

This report is divided into the following sections: (1) surface science center, (2) materials, (3) TNS project, (4) Tokamak Experimental Power Reactor, (5) fusion systems engineering, and (6) applied plasma physics. Data are given on materials problems, safety studies, neutronics, tritium control, and cross section studies. (MOW)

42315 (EPRI-ER—328-SR) **Low activation materials assessment for fusion reactors.** Kummer, D.L. (ed.). (McDonnell Douglas Astronautics Co., St. Louis, Mo. (USA)). Mar 1977. 107p. (CONF-760252—). Dep. NTIS, PC A06/MF A01.

From Symposium on low activation materials assessment for fusion reactors; San Francisco, California, United States of America (USA) (19 Feb 1976).

The case for a low activity fusion reactor was examined. Possibilities for hands-on maintenance were judged to be increased substantially for a low activity design. The resultant reduction in maintenance time and improvement in plant availability was identified as the greatest potential payoff for a low activity reactor. Considerable differences of opinion were expressed about the location within the reactor core where hands-on maintenance may be possible. Other potential advantages discussed were siting, accident down time, public acceptance and transportation/storage of activated components. Material choices for low activity first wall/blanket structure are limited. Aluminum, vanadium, titanium, silicon carbide and graphite appear most appropriate. Only aluminum, silicon carbide and carbon, of extremely high purity (few ppM of objectional impurities, i.e., iron) have activation characteristics that may permit the full potential of a low activation design to be realized. Major limitations of aluminum alloys are a temperature limit of about 200°C and radiation induced embrittlement which may result in reduced component life. Ceramics have the major limitations of brittleness and fabrication constraints. Such limitations will tend to increase the cost of power and must be weighed very carefully against the increased availability provided by hands-on maintenance.

42316 (EUR-CEA-FC—852) **Use of limiters made of graphite and boron carbide in the TFR machine.** (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Oct 1976. 26p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Two limiter materials with a low atomic number have recently been tested in TFR: graphite 5890 CL-PT and boron carbide (Carbone Lorraine). Their characteristics were measured. The boron carbide limiter behaved well up to 80KA but was destroyed at higher currents. The graphite limiter behaved well up to 400KA giving a plasma at least as good as the plasma obtained with the previous molybdenum limiters. Spectroscopic, bolometric, QWAASS and mass analysis data support this conclusion.

42317 (JAERI-M—6432) **Estimate of low-Z materials for the first wall of JT-60.** Gomay, Y.; Nomura, S.; Fukuda, K.; Nakamura, H.; Muraoka, S. (Japan Atomic Energy Research Inst., Tokyo). Mar 1976. 100p. (In Japanese). Dep. NTIS (US Sales Only), PC A05/MF A01.

Low atomic number ceramic materials are estimated for application to the first wall of a plasma feasibility experiment device (JT-60). Carbon and silicon carbide are shown to be the potential materials. They are thus studied concerning generation of impurities at the wall by particle bombardment, vacuum properties and typical design problems. We also evaluated their material properties for application to the first wall. Considering quantitatively, there exist such problems as chemical sputtering, outgassing rate and micropowder generation of graphite materials by a discharge which need basic research. Design criteria for the low-Z material first wall must be considered and the data of material properties necessary for the design be prepared.

42318 (ORO—3557-15) **Proton sputtering. Final report.** Finfgeld, C.R. (Roanoke Coll., Salem, Va. (USA). Dept. of Physics). 1975. Contract EY-76-S-05-3557. 45p. Dep. NTIS, PC A03/MF A01.

This research provides sputtering yields as a function of energy for H^+ and D^+ on several representative pure metallic elements, in the absence of surface contaminants. The experimental technique and apparatus are described. Data are given for Au, Co, Ta, W, and Mo. (MOW)

42319 (SAND—77-0204) **Electron beam fusion data acquisition program DATAIN (EBD).** Boyer, W.B. (Sandia Labs., Albuquerque, N.Mex. (USA)). Feb 1977. Contract EY-76-C-04-0789. 33p. Dep. NTIS, PC A03/MF A01.

This report describes the e beam automatic data acquisition program DATAIN. The program was written for a Modular Computer Systems Modcomp II computer interfaced to Tektronix R7912 Transient Digitizers. Operator Communications and data handling steps are described.

42320 (UCID—17431) **DT fusion neutron irradiation of LLL "tritium-tricked" niobium, BNL—LASL superconductor wires, BPNL wire-foil packages.** MacLean, S.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 13 Jan 1977. Contract W-7405-ENG-48. 6p. Dep. NTIS, PC A02/MF A01.

The DT fusion neutron irradiation of eight LLL "tritium-tricked" niobium foils, eleven BNL-LASL superconductor wires, and two wire-foil packets from BPNL is described The sample position, beam-on time, and neutron dose record are given. The maximum neutron fluence on any sample was 9.66×10^{18} neutrons/cm^2.

42321 **Reactor control system by means of neutral-beam injection.** Ladikov, Yu.P.; Paguta, M.T. (AN Ukrainskoj SSR, Kiev. Inst. Kibernetiki). *Ukr. Fiz. Zh. (Russ. Ed.);* **21**: No. 8, 1287-1295(Aug 1976). (In Russian).

For English translation see the journal Ukr. Phys. J.

Stability of the feedback control system for a steady fusion reactor was studied using a mathematical model based on the energy and particle densities balance of homogeneous plasma, a neutral-beam injector being applied as a control element of the system. Linearizing the balance equation analysis of the system dynamics stability may be reduced to numerical calculations of eigenvalues. The performed analysis showed that the feedback control system based on the neutralbeam injector used for stabilization of the thermonuclear plasma temperature permits stabilizing the reactor operation within a wide range of temperatures.

42322 **Data on rotating plasma operation in Tornado traps.** Lehnert, B. (Kungliga Tekniska Hoegskolan, Stockholm (Sweden)). *Nucl. Instrum. Methods;* **140**: No. 2, 315-331(15 Jan 1977).

Rotating plasma operation in spiral coil 'Tornado' traps provides a unique combination of confinement and heating properties. Such a system consists of a closed and compact magnetic bottle to which the crossed-field technique can be applied, in absence of end insulators and their critical velocity limitation effect. This is expected to lead to the generation and heating of fully ionized plasmas within a large range of ion densities, temperatures, and rotational velocities. Provided that stable operation becomes possible at high temperatures and the effects due to the asymmetries of the spiral coil structure can be neglected, it is likely that Tornado traps can be used as strong neutron sources of moderately large dimensions and technically realizable parameter values. Some detailed data and operation ranges are outlined for the 'Tornado 650' device in Leningrad, and for a somewhat larger device which may be operated as a neutron source.

42323 **Equilibrium pressure and solubility of hydrogen in liquid lithium.** Katsuta, H.; Ishigai, T.; Furukawa, K. (Japan Atomic Energy Research Inst., Tokai-mura, Ibaraki-ken). *Nucl. Technol.;* **32**: No. 3, 297-303(Mar 1977).

Equilibrium hydrogen pressures (P/sub H_2/) were measured for the two-phase system, Li-LiH, for the liquid lithium of dilute solutions of 2.0×10^{-3} to 1.3×10^{-2} atomic ratio (H/Li), and for the liquid lithium controlled by a cold trap at temperatures between 200 and 450°C. From the variation of P/sub H_2/ with temperature, the apparent heat of solution of hydrogen in liquid lithium was obtained as 34 and 19 kcal/mol for the Li-LiH and for the dilute solutions, respectively. For the liquid lithium controlled by the cold trap at 203°C, the heat of solution was 19 kcal/mol. Using the Sieverts constant, which was obtained experimentally in this work, it was possible to determine the hydrogen concentration in liquid lithium from the P/sub H_2/. The hydrogen-solubility in liquid lithium in the concentration $<2 \times 10^{-2}$ H/Li (corresponding to the temperature lower than 350°C) was estimated from the hydrogen concentration data obtained through the P/sub H_2/ of the Li-LiH system. Although the cold trap could effectively control the hydrogen concentration in liquid lithium, this solubility was apparently lower than that obtained from the Li-LiH by factors of 2 to 3 at the same temperature. The difference can be attributed to the interactions among hydrogen and other impurities and to compound formations such as Li_2H.

GENERAL AND MISCELLANEOUS

MANAGEMENT

42324 (ERDA—77-49) **Comparison of compensation paid scientists and engineers in research and development. 1976 data.** (Energy Research and Development Administration, Oak Ridge, Tenn. (USA). Oak Ridge Operations Office). 1977. 30p. Dep. NTIS, PC A02/MF A01.

This study compares the characteristics and compensation of ERDA contractor-operated laboratories with those reported in the 1976 National Survey of Compensation Paid Scientists and Engineers Engaged in Research and Development Activities. Characteristics such as salary levels, degree levels, maturity, etc., of ERDA laboratories are included. In addition to showing statistical data for 1976, significant differences from last year's data are presented for comparative analysis. The data are as of September 1, 1976, for Educational Institutions and August 1, 1976, for all other participants. (RWR)

MATHEMATICS AND COMPUTERS

REFER ALSO TO CITATION(S) 41032, 42337

42325 (ANL—7411(Suppl.10)) **Argonne Code Center: compilation of program abstracts.** Butler, M.K.; DeBruler, M.; Edwards, H.S. (Argonne National Lab., Ill. (USA)). Aug 1976. Contract W-31-109-ENG-38. 518p. Dep. NTIS $12.75.

This publication is the tenth supplement to, and revision of, ANL-7411. It contains additional abstracts and revisions to some earlier abstracts and other pages. Sections of the document are as follows: preface; history and acknowledgements; abstract format; recommended program package contents; program classification guide and thesaurus; and abstract collection. (RWR)

42326 (COO—2383-0035) **Future developments in stiff integration techniques: stability of methods that do not use an exact Jacobian.** Gear, C.W. (Illinois Univ., Urbana (USA). Dept. of Computer Science). Dec 1976. Contract EY-76-S-02-2383.A001. 18p. (UIUCDCS-R—76-839). Dep. NTIS, PC A02/MF A01.

Although there are many open theoretical questions for stiff (and nonstiff) variable-order, variable-step methods, it seems unlikely that there will be any major computational advances as far as integration methods for the general nonlinear problem. The major drawback of many of the methods that have been proposed in the last few years is that they involve too many matrix operations, or operations on larger matrices than in some of the more straightforward techniques, such as the backward differentiation formulas. However, advances in techniques for handling large, sparse matrices may affect the choice of integration method for very large problems. This paper examines possible improvements that might occur through the use of very inaccurate Jacobians. Such Jacobians might be chosen so that the LU decomposition is particularly simple. Some methods are shown to remain stable in spite of very large errors in the Jacobian. These results are preliminary, but suggest that further speed increases in very large problems are possible. 2 figures.

42327 (LA—6482-MS) **Variances and covariances of the normal order statistics for sample sizes 2 to 50.** Tietjen, G.L.; Kahaner, D.K.; Beckman, R.J. (Los Alamos Scientific Lab., N.Mex. (USA)). Aug 1976. Contract W-7405-ENG-36. 74p. Dep. NTIS, PC A05/MF A01.

Tables of the variances and covariances of the normal order statistics for samples of size N less than or equal to 20 were given by Sarhan and Greenberg (1956), based on tables of expected values given by Teichroew (1956). This report extends these results to N less than or equal to 50. 2 tables.

42328 (ORO—5046-1) **Extension of quasi-Newton methods to constrained optimization and to general systems of nonlinear equations and inequalities. Progress report, February 1, 1976—January 31, 1977.** Tapia, R.A. (Rice Univ., Houston, Tex. (USA)). 1977. Contract EY-76-S-05-5046. 6p. Dep. NTIS $3.50.

The research proposed under ERDA Contract No. E-(40-1)-5046 was successfully completed. A new theory for applying quasi-Newton (secant) methods to general constrained optimization problems was developed. This general theory is one of the first theories of its kind. By design the theory is modular in that an important intermediate part is the existing approach to unconstrained optimization. As a consequence one can immediately extend an algorithm for unconstrained optimization to one for constrained optimization in an effective manner. Preliminary numerical experimentations were very satisfying and impressive.

42329 (SAND—77-0612) **CDC6600 subroutine for normal random variables.** Amos, D.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Apr 1977. Contract EY-76-C-04-0789. 7p. Dep. NTIS, PC A02/MF A01.

A value y for a uniform variable on (0,1) is generated and a table of 96-percent points for the (0,1) normal distribution is interpolated for a value of the normal variable x(0,1) on 0.02 less than or equal to y less than or equal to 0.98. For the tails, the inverse normal is computed by a rational Chebyshev approximation in an appropriate variable. Then X = x sigma + μ gives the X(μ,sigma) variable.

42330 (SLAC—196) **DPAK and HPAK: a versatile display and histogramming package.** Logg, C.A.; Boyarski, A.M.; Cook, A.J.; Cottrell, R.L.A. (Stanford Linear Accelerator Center, Calif. (USA)). Jun 1976. Contract EY-76-C-03-0515. 95p. Dep. NTIS, PC A05/MF A01.

This document describes the features of a display and histogram package which requires a minimal number of subroutine calls in order to generate graphic output in many flavors on a variety of devices. Default options are preset to values that are generally most wanted, but the default values may be readily changed to the user's needs (e.g., size of plot, type of scales, scale factors, plot characters, super-imposing several plots, etc.). The description falls naturally into two parts, namely, the set of routines (DPAK) for displaying data on some device, and the set of routines (HPAK) for generating histograms. HPAK provides a means of allocating memory for histograms, accumulating data into histograms, and subsequently displaying the histograms via calls to the DPAK routines. Histograms and displays of either one or two independent variables can be made. 10 figures.

42331 (SU—326P18X10) **Systems Optimization Project. Progress report, 1 October 1975—30 June 1976.** Dantzig, G.B.; Cottle, R.W.; Wilson, R.B. (Stanford Univ., Calif. (USA)). Jul 1976. Contract EY-76-S-03-0326-018. 36p. Dep. NTIS, PC A03/MF A01.

The purpose of the Systems Optimization Laboratory is to advance the power of optimization methods on a broad front. This ranges from basic research on the abstract mathematical theory of optimization to the implementation in efficient, tested, documented computer codes of the algorithmic procedures developed from the basic theory. In the past year the Laboratory's basic research work has focused on three main topics: further development of techniques of large-scale linear programing, an emphasis motivated by the intensive demand for optimizing energy planning systems over time; completion of general-purpose codes, using several different algorithmic methods, for nonlinear programing, and development of a variety of special-purpose algorithms and codes for specially-structured nonlinear programing problems; and the development of algorithms for fixed-point and equilibrium problems. Part I describes the Laboratory's published output appearing during the reporting period in its series of technical reports, and is confined to those reports funded completely or in part by the ERDA contract, except as noted. Part II summarizes the Laboratory's software development activities. Part III reports more generally on the Laboratory's other activities: staff and visitors, the role of the Workshop, etc., and also includes a brief summary of the Laboratory's recent work on the development of the PILOT series of models for policy analysis of investment problems in the energy sector. A complete listing of the Laboratory's reports, accompanied by abstracts of their contents, is provided in Part IV. The report is administrative in nature, with no data. (RWR)

42332 (SU—326-P.39-16) **Studies in the organization of computer systems. 1976 progress summary. Technical note No. 100.** Flynn, M.J. (Stanford Univ., Calif. (USA)). Nov 1976. Contract EY-76-S-03-0326-039. 13p. Dep. NTIS, PC A02/MF A01.

This project studied theoretical and practical methods for the categorization, analysis and synthesis of computing systems. In particular, an Emulation Laboratory was developed for the analysis of computer architectures and interpretive computer designs. A memory hierarchy management study developed techniques to improve the performance of multilevel virtual memory systems. Efforts in the areas of parallel processors and program representation continued, together with a newly initiated study on topology of algorithms. 1 figure.

42333 (SU-SEL—76-025) **"Almost-exact" solution to the N-processor, M-memory bandwidth problem. Technical report No. 117.** Rau, B.R. (Stanford Univ., Calif. (USA). Stanford Electronics Labs.). Jun 1976. Contract EY-76-S-03-0034-039. 29p. (SU—326-P.39-12). Dep. NTIS, PC A03/MF A01.

A closed-form expression is derived from the memory bandwidth obtained when N processors are permitted to generate requests to M memory modules. Use of generating functions is made, In a rather unusual fashion, to obtain this expression. The one approximation involved is shown to result in only a very small error—and that, too, only for small values of M and N. This expression, which is asymptotically exact, is shown to be more accurate than existing closed-form approximations. Lastly, a family of asymptotically exact solutions is presented which are easier to evaluate than is the first one. Although these expressions are less accurate than the previously derived closed-form solution, they are, nevertheless, better than existing solutions. This family of solutions is shown to include a couple of existing solutions. 8 tables.

42334 (UCRL—79161) **New design for interfacing computers to the Octopus network.** Sloan, L.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Mar 1977. Contract W-7405-ENG-48. 14p. (CONF-760972—2). Dep. NTIS, PC A02/MF A01.

From Network Systems Corporation users symposium; Minneapolis, Minnesota, United States of America (USA) (16 Sep 1976).

The Lawrence Livermore Laboratory has several large-scale computers which are connected to the Octopus network. Several

difficulties arise in providing adequate resources along with reliable performance. To alleviate some of these problems a new method of bringing large computers into the Octopus environment is proposed.

42335 Comparison of two adaptive identification methods for monitoring and diagnosis of an experimental nuclear reactor. Zwingelstein, G.; Blanc, P. (CEA, CEN, Saclay, Gif Sur Yvette, Fr). pp 436-438 of In Proceedings of the 14th conference of the Institute of Electrical and Electronics Engineers. New York; IEEE (1975). From 14. IEEE conference; Houston, TX, USA (10 Dec 1975).

This paper deals with the comparison of two adaptive methods based upon sensitivity equations for use in the surveillance and diagnosis of an experimental nuclear reactor. The surveillance and diagnosis are obtained by a real-time comparison of reference parameters and the actual parameters given by the adaptive algorithm. The first algorithm uses an on-line, steepest descent method. Results obtained with this algorithm using experimental data from a reactor are given using two different criteria. The second algorithm uses both sensitivity equations and a recursive least squares method. An example is given using the experimental model of the same reactor. Both algorithms described in this paper are easily implementable on a minicomputer and are not sensitive to a priori knowledge of the statistical properties of the noise. These algorithms are also suitable for the surveillance of nonlinear processes.

42336 Angular overconvergence for rational functions converging geometrically on (0, + infinity). Saff, E.B.; Varga, R.S. pp 238-256 of In Theory of approximation with applications. New York; Academic Press, Inc. (1976).

The phenomenon of overconvergence is investigated for the following case: it is assumed that f(z) is defined (finite) on a closed line segment [a,b]; there is a sequence of rational functions which converge geometrically to f on the line segment; the set of poles of the sequence has no accumulation points on the open subinterval (a,b) of [a,b]. The conclusion is that the sequence converges geometrically to an analytic extension of f on some open set in the plane containing (a,b). (RWR)

INFORMATION HANDLING

42337 (IS—4104) Operation and maintenance of the Rare-Earth Information Center's Information Retrieval System (RICIRS) version 2. Moon, L.C. (Ames Lab., Iowa (USA)). Jan 1977. Contract W-7405-ENG-82. 38p. Dep. NTIS, PC A03/MF A01.

The RICIRS system is a key word-based retrieval system capable of retrieving bibliographic information from a direct-access device. The biblographic information is compiled by the Rare-Earth Information Center (RIC) by careful inspection and key word extraction of the documents. This report describes the constructing of retrieval requests and the updating of the data bases for this information retrieval system. The system is written for an IBM 360-370 OSMVT environment. It is written in PL/I optimized codes. 4 figures.

42338 (LBL—6122) Investigation into the computerized data bases of the Employment and Training Administration. Regional Management Information System Project (RMIS) report on second-year activities, 1975—1976. Postle, W.; Heckman, B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jan 1977. Contract W-7405-ENG-48. 60p. Dep. NTIS, PC A08/MF A01.

The research and development project discussed was aimed at creating the necessary computer system for the rapid retrieval, analysis, and display of information to meet the individual and nonroutine needs of the Department of Labor's Employment and Training Administration and the general public. The major objective was to demonstrate that it was both feasible and practical to organize data that are currently available and to provide planning and management information in a much more usable and timely fashion than previously possible. Fast access to data with a system which is easy to use was an important project goal. Programs were written to analyze and display data by means of bar, pie, and line charts, etc. Although prototypical interactive retrieval, analysis, and report formation tools have been developed, further research and development of interactive tools is required. (RWR)

42339 (UCID—17378) Set Theoretic Data Structures (STDS): a tutorial. Birss, E.W.; Yeh, J.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 31 Jan 1977. Contract W-7405-ENG-48. 52p. Dep. NTIS, PC A04/MF A01.

Extended Set Theory as a data base management discipline has received attention in the data base literature. Set Theoretic Information Systems Corporation has, for some time, marketed a data base system based on the foundation of Extended Set Theory. This system is called Set Theoretic Data Structures (STDS). A series of examples shows that STDS is similar to relational algebraic data base management systems. The advantages of STDS are its straight-forward data base design, compact data representation, and flexible, powerful data manipulation operators, while its limitations are its low-level primitive user interface and the partial implementation of the Extended Set Theoretic concepts. To make STDS very attractive, a "user-friendly" interface should be developed, and some distinctive features of extended Set Theory (such as sets of sets) should be implemented. 8 figures, 1 table.

CORPORATE INDEX

In the corporate index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

Each entry under a corporate heading gives the report title and the volume and abstract numbers. Report numbers, if applicable, are given in parentheses at the end of the entry.

ERDA Energy Information Data Base: Corporate Author Entries (TID-4585) is used in the standardization of corporate entries. TID-4585 is available for purchase from the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, Virginia 22161.

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Development of a solar-powered residential air conditioner: screening analysis, 2:41209 (N—76-30659)
Development of a solar-powered residential air conditioner: system optimization preliminary specification, 2:41210 (N—76-30660)

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Ames Lab., Iowa (USA)
Operation and maintenance of the Rare-Earth Information Center's Information Retrieval System (RICIRS) version 2, 2:42337 (IS—4104)
Simulation for control synthesis of a plutonium—uranium extraction process, 2:41094 (IS-M—25)

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Theoretical concepts useful in the calculation or storage of phase diagrams of ionic systems, 2:41863 (CONF-770116—1)
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Plasma heating by cluster injection: basic features and expected behaviour, 2:42213 (EUR-CEA-FC—848)
Plasma heating in the TM-3 Tokamak at the electron cyclotron resonance in magnetic fields up to 25kGs, 2:42214 (EUR-CEA-FC—855-TR)
Use of limiters made of graphite and boron carbide in the TFR machine, 2:42316 (EUR-CEA-FC—852)
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Measurement of the ion temperature in Petula from the Doppler broadening of impurity lines, 2:42225 (EUR-CEA-FC—862)
Atlantic Richfield Hanford Co., Richland, Wash. (USA)
Laser Raman spectrometric determination of oxy-anions in nuclear waste materials, 2:41868 (ARH-SA—279)
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High-temperature piping design technology quarterly technical progress report, October—December 1976, 2:41378 (AI-ERDA—13191)
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Tank study committee report, 2:41888 (RFP—2639)
Atomova Elektraren Bohunice, Jasiovske Bohunice (Czechoslovakia)
Corrosion in condensers and coolers of nuclear power due to cooling water, 2:41813 (EBO-P—673)
Fuel rods vibration in fast breeder reactors, 2:41382 (CS-INIS—29)
Turbulent temperature and pressure pulsations in longitudinal flow through rod bundles, 2:41453 (CS-INIS—30)
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Evaluation of uncertainties in the gamma-ray heating analysis of a PWR, 2:41329 (CONF-770401—4)
Ship collision study. Present situation survey. Final report, Jul 1974—Oct 1975, 2:41508 (PB—254750)
Three-dimensional synthesis approach to reactor internal gamma-ray heating, 2:41328 (CONF-770401—3)
Baker (Michael), Jr., Inc., Beaver, Pa. (USA)
Inactive and abandoned underground mines. Water pollution prevention and control, 2:42011 (PB—258263)
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Extreme solar ultraviolet monitor (ESUM) for atmosphere Explorer, 2:42166 (N—76-29361)
Ball Bros. Research Corp., Boulder, Colo. (USA). Aerospace Div.
Dewar technology study. Final report, 2:41883 (N—76-27444)
Battelle Columbus Labs., Ohio (USA)
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Source assessment: glass container manufacturing plants. Final report, Sep 1975—Sep 1976, 2:41977 (PB—262002)
Battelle Pacific Northwest Labs., Richland, Wash. (USA)
Evaluation of Millstone Nuclear Power Plant, Environmental Impact prediction, based on monitoring programs, 2:41313 (BNWL—2152)
Evaluation of nuclear power plant environmental impact prediction, based on monitoring programs. Summary and recommendations, 2:41492 (BNWL—2153)
Performance targets for fusion-fission (hybrid) reactors, 2:42272 (BNWL—2139)
Proceedings of the workshop on measurement of heavy elements in vivo, 2:42093 (BNWL—2088)
Quarterly report on the strontium heat source development program and the beneficial isotopes utilization program, Division of Nuclear Research and Application for October—December 1976, 2:41155 (BNWL—1945-31)
Radiological physics and dosimetry research with a small positive ion accelerator, 2:42076 (BNWL-SA—5966)
Beckman Instruments, Inc., Anaheim, Calif. (USA)
Shipboard oil-in-water monitor. Final report 24 May 74—30 Jun 76, 2:40983 (AD-A—028785)
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A qualitative study of consumer attitudes toward energy conservation, 2:41583 (PB—254564)

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Closed cycle, high-temperature central receiver concept for solar electric power, 2:41202 (PB—254399)
Bolt, Beranek and Newman, Inc., Arlington, Va. (USA)
Hearing conservation program prototype phase final report. Technical report, 2:42136 (AD-A—030896)
Bonner and Moore Associates, Inc., Houston, Tex. (USA)
Crude supply alternatives for the northern tier states. Volume I. Executive summary, 2:41643 (PB—255992)
Crude supply alternatives for the northern tier states. Volume II. Technical report, 2:41644 (PB—255993)
British Steel Corp., Sheffield
Metallurgical factors controlling weld metal toughness in the seam welding of line pipe, 2:41758 (PB—256057)
Brookhaven National Lab., Upton, N.Y. (USA)
Assessment of non-linear analysis finite element program (NONSAP) for inelastic analysis, 2:41465 (BNL-NUREG—50615)
Neutral beam injector research and development work in the USA, 2:42302 (BNL—22436)
Possible effects of lowering the periodicity in ISABELLE, 2:41925 (BNL—22237)
Preaccident modeling of an LMFBR plant for SSC-L, 2:41509 (BNL-NUREG—50602(Pt.1))
Brown Univ., Providence, R.I. (USA). Dept. of Engineering
Assessment of cadmium sulfide photovoltaic arrays for large scale electric utility applications. Final report, 2:41199 (PB—255646)
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C

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Analysis of loss of coolant accidents, 2:41515 (IAEA-CN—36/127)
Arguments for the installation of small LWR nuclear power plants in developing countries, 2:41315 (IAEA-CN—36/89)
Assessment methodology of environmental risks associated with radioactive waste management, 2:41113 (IAEA-CN—36/28)
Basic performance problems and prospects for 1200-1500 Mw gas-cooled fast reactors with the dissociating coolant, 2:41397 (IAEA-CN—36/332)
Behaviour of mixed monocarbide and -nitride fuel under high power density, 2:41399 (IAEA-CN—36/369)
CANDU: Canadian experience and expectations with the heavy-water reactor, 2:41367 (IAEA-CN—36/179)
CANDU fuel: fifteen years of power reactor experience, 2:41368 (IAEA-CN—36/184)
Characteristics and behaviour of the PHENIX fuel element, 2:41394 (IAEA-CN—36/268)
Contribution of nuclear energy to the meeting of Italy's electric power requirements, 2:41308 (IAEA-CN—36/464)
Co-operation of the CMEA member countries in the developing power reactors of various types, including some aspects of their nuclear fuel cycles, 2:41301 (IAEA-CN—36/6)
Correlation of composition, structure characteristics and properties for high level waste solidification products, 2:41134 (IAEA-CN—36/470)
Criticality control and long term storage of spent fuel, 2:41105 (IAEA-CN—36/33)
Design of KWU LWR safety systems, 2:41516 (IAEA-CN—36/132)
Development of methods for solidification and disposal of fuel cycle radioactive wastes, 2:41122 (IAEA-CN—36/350)
Development of radioactive waste management at Japan Atomic Energy Research Institute, 2:41115 (IAEA-CN—36/156)
Development of the national nuclear programme and preparations for the introduction of nuclear power in Hungary, 2:41305 (IAEA-CN—36/420)
Discharge into the atmosphere of volatile fission products from nuclear power stations and fuel reprocessing plants and the perspectives of their retention, 2:41132 (IAEA-CN—36/317)
Energy in developing countries: prospects and problems, 2:41628 (IAEA-CN—36/581)
Energy policy and public acceptance, 2:41493 (IAEA-CN—36/588)
European Community care for nuclear power, 2:41304 (IAEA-CN—36/365)
European in-pile investigations on fast breeder reactor safety, 2:41519 (IAEA-CN—36/245)
Evaluation of in-reactor measurements of fuel rod deformations, 2:41488 (IAEA-CN—36/495)
Evaluation of local accidents in LMFBR, 2:41527 (IAEA-CN—36/551)
Evaluation of solidification matrices proposed for nuclear power plant radwaste, 2:41131 (IAEA-CN—36/186)
Evaluation of the limits of radioactive waste disposal into water systems of international importance, 2:41140 (IAEA-CN—36/346)
Experience from construction and operation of Karachi nuclear power plant, 2:41371 (IAEA-CN—36/547)
Experience in the manufacture of nuclear equipment in India, 2:41307 (IAEA-CN—36/462)
Experience of European irradiated fuel transport - the first four hundred tonnes, 2:41106 (IAEA-CN—36/69)
Experience of NPS construction in the People's Republic of Bulgaria, 2:41332 (IAEA-CN—36/537)
Experience with Pu-recycle fuel for large light water reactors in the Federal Republic of Germany, 2:41318 (IAEA-CN—36/558)
Experimental investigations of the power ramp failure propensity of LWR fuel, 2:41520 (IAEA-CN—36/279)
Experimental study of utilization of nuclear power heating plants for big towns and industrial agglomerations in Russia, 2:41451 (IAEA-CN—36/465)
Fabrication and irradiation performance of French HTGR fuel, 2:41084 (IAEA-CN—36/270)
Fabrication of nuclear fuel elements in Mexico, 2:41087 (IAEA-CN—36/540)
Fast reactor fuel design and development, 2:41391 (IAEA-CN—36/64)
Fuel cycle of the LWR system in the Federal Republic of Germany, 2:41111 (IAEA-CN—36/95)
Fuel reliability in light water reactors, experience and assessment for the future, 2:41316 (IAEA-CN—36/474)
Gas-cooled fast reactor safety, 2:41513 (IAEA-CN—36/36)
Gas-cooled high temperature reactor: perspectives, problems and programmes, 2:41356 (IAEA-CN—36/94)
Goals, objectives and criteria for the management of nuclear wastes: rethinking the problem, 2:41127 (IAEA-CN—36/511)
Handling of waste at Swedish nuclear power plants, 2:41121 (IAEA-CN—36/282)
HTGR fuel and fuel cycle technology, 2:41359 (IAEA-CN—36/578)
Indian experience in the training of manpower for nuclear power programme, 2:41306 (IAEA-CN—36/459)

India's nuclear power programme and constraints encountered in its implementation, 2:41369 (IAEA-CN—36/385)
Innovations in PHWR design, integration of nuclear power stations into power systems and role of small size nuclear power plants in a developing country, 2:41370 (IAEA-CN—36/394)
Integrated planning for a fuel industry with emphasis on minimum size to fabricate own fuel, 2:41086 (IAEA-CN—36/386)
Introducing experimental evidence in critical aspects of SNR fuel design, 2:41403 (IAEA-CN—36/489)
Italian progress on LWR fuel design, manufacturing, testing and management, 2:41331 (IAEA-CN—36/310)
LWR safety research in the Federal Republic of Germany, 2:41525 (IAEA-CN—36/541)
Management and control of radioactive wastes from uranium-milling operations, 2:41125 (IAEA-CN—36/479)
Management of high level radioactive waste, 2:41119 (IAEA-CN—36/226)
Management of high level waste, 2:41112 (IAEA-CN—36/15)
Management of radioactive waste and plutonium in the Swedish perspective, 2:41128 (IAEA-CN—36/554)
Management of radioactive wastes: an overview of the Indian programme, 2:41123 (IAEA-CN—36/388)
Management of radioactive wastes from nuclear fuels and power plants in Canada, 2:41116 (IAEA-CN—36/178)
Management of wastes containing radioactivity from mining and milling of uranium ores in Northern Australia, 2:41124 (IAEA-CN—36/418)
Medium-size nuclear plants, 2:41333 (IAEA-CN—36/568)
MSR (Pu converters) and MSBRs in commercial nuclear power stations, 2:41400 (IAEA-CN—36/424)
Near term feasibility of nuclear reactor for sea-water desalting: coupling of standard condensing nuclear power stations to low grade heat multieffect distillation plants, 2:41447 (IAEA-CN—36/52)
Need for high performance breeder reactors, 2:41402 (IAEA-CN—36/478)
Nuclear fuel in water reactors: manufacturing technology operational experience and development activities in the Federal Republic of Germany, 2:41083 (IAEA-CN—36/103)
Nuclear merchant ship propulsion, 2:41507 (IAEA-CN—36/93)
Nuclear steam superheat results and current prospects, 2:41358 (IAEA-CN—36/325)
Nuclear transmutation of actinides other than fuel as a radioactive waste management scheme, 2:41133 (IAEA-CN—36/366)
Options for the disposal of high-level radioactive waste, 2:41136 (IAEA-CN—36/67)
Performance and reliability of LWR fuel, 2:41317 (IAEA-CN—36/475)
Performance evaluation of UO_2-Zr fuel in power ramp tests, 2:41487 (IAEA-CN—36/203)
Physical and technical aspects of nuclear and chemical safety of APS with fast reactors cooled with N_2O_4, 2:41521 (IAEA-CN—36/322)
Physical characteristics of fast power reactor fuel and their effect on the fuel cycle, 2:41396 (IAEA-CN—36/326)
Plutonium fuel and fuel elements for power reactors, 2:41444 (IAEA-CN—36/353)
Plutonium use - present status and perspectives, 2:41445 (IAEA-CN—36/477)
Plutonium utilization in thermal and fast reactor in Japan, 2:41303 (IAEA-CN—36/162)
Present status of fuel researches for VHTR in Japan, 2:41357 (IAEA-CN—36/168)
Present trends in radioactive waste management policies in OECD countries and related international co-operative efforts, 2:41126 (IAEA-CN—36/491)
Production of refined intermediate fuels with high temperature reactors, 2:41450 (IAEA-CN—36/376)
Programme and current status of fast breeder reactor development in Japan, 2:41392 (IAEA-CN—36/164)
Pu utilization in fast-breeder and in light-water reactors in Italy, 2:41320 (IAEA-CN—36/577)
PWR and BWR light water reactor systems in the USA and their fuel cycle, 2:41319 (IAEA-CN—36/566)
Radioactive waste disposal in geological formations, 2:41138 (IAEA-CN—36/313)
Radioactive waste management in Belgium, 2:41117 (IAEA-CN—36/187)
Rapsodie: A closed fuel cycle, 2:41393 (IAEA-CN—36/266)
Reactivity requirements and safety systems for heavy water reactors, 2:41522 (IAEA-CN—36/393)
Reactor waste heat utilization and district heating reactors. Nuclear district heating in Sweden - Regional reject heat utilization schemes and small heat-only reactors, 2:41448 (IAEA-CN—36/275)
Recent U.S. reactor operating experience, 2:41309 (IAEA-CN—36/483)
Research and development of spent fuel shipping casks and the criteria for seagoing vessel carrying casks, 2:41889 (IAEA-CN—36/155)
Review of Dutch geologic waste disposal programme, 2:41137 (IAEA-CN—36/289)
Safety analysis of the THTR-300 MW(e)-prototype-reactor and future HTR's under extreme accident conditions, 2:41528 (IAEA-CN—36/560)
Safety and radiation protection aspects of the management of radioactive wastes of high level activity, 2:41120 (IAEA-CN—36/231)
Safety aspects and operating experience of LWR plants in Japan, 2:41526 (IAEA-CN—36/544)
Safety considerations in fast reactor fuel development, 2:41512 (IAEA-CN—36/18)
Safety considerations of PWR's, 2:41524 (IAEA-CN—36/512)
Safety of heavy-water reactors, 2:41518 (IAEA-CN—36/181)
Safety of the liquid metal cooled fast breeder reactor and aspects of its fuel cycle, 2:41529 (IAEA-CN—36/572)
Scientific prerequisites and practice for using deep water-bearing horizons for disposal of liquid radioactive wastes, 2:41139 (IAEA-CN—36/345)
SGHWR fuel performance, safety and reliability, 2:41366 (IAEA-CN—36/63)
SGHWR safety design and evaluation, 2:41514 (IAEA-CN—36/73)
Some problems of the safety of PWR nuclear power plants viewed from the technical standpoint, 2:41523 (IAEA-CN—36/467)
Some UK experience and practice in the packaging and transport of irradiated fuel, 2:41107 (IAEA-CN—36/70)
Spanish program on disposal of radioactive wastes, 2:41118 (IAEA-CN—36/206)
Spent fuel transportation problems, 2:41108 (IAEA-CN—36/316)
Status and program of development of the fast breeder reactor system in the U.S., 2:41401 (IAEA-CN—36/427)
Status and programme for the fast breeder reactor in the UK, 2:41390 (IAEA-CN—36/54)
Status and programme of development of the fast breeder reactor systems in the Federal Republic of Germany, 2:41404 (IAEA-CN—36/497)
Status and prospects of thermal breeders, 2:41395 (IAEA-CN—36/302)
Status for seismic design requirements of nuclear power plants in Japan, 2:41517 (IAEA-CN—36/159)
Status of the development of mixed oxide fuels in PNC, 2:41489 (IAEA-CN—36/553)
Structure of atomic power industry with allowance for energy production other than electricity, 2:41438 (IAEA-CN—36/337)
Summary of LWR safety research in the USA, 2:41530 (IAEA-CN—36/584)
Technological aspects of fuel manufacture for different power reactors, 2:41085 (IAEA-CN—36/352)
Trends in the development of reactor containments, 2:41469 (IAEA-CN—36/306)
Tritium formation and elimination in light-water electronuclear plants, 2:41497 (IAEA-CN—36/238)
UK experience of planning the nuclear contribution to the UK power programme, 2:41302 (IAEA-CN—36/53)
Uranium-graphite reactor development in the USSR, 2:41360 (IAEA-CN—36/586)
Use of nuclear reactors for central heat supply and district heating, 2:41449 (IAEA-CN—36/338)
USSR fast reactor development program and its current state, 2:41398 (IAEA-CN—36/356)
Waste management implications of irradiated nuclear fuel storage, 2:41104 (IAEA-CN—36/23)
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Development of F_2 two-step fluorination process for non-aqueous reprocessing, 2:41096 (JAERI-M—6393)
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Scanning electron microscope examination of samples from Herty Foundation in development of fluoride-resistant HEPA filter media, 2:41886 (K/TL—639)

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Nonlinear saturation of the dissipative trapped-electron instability, 2:42246 (PPPL—1337)
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Equations of motion for a mass particle elastically mounted on a disk subjected to transverse and rotational accelerations, 2:41879 (SAND—76-8262)
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Optimizing the use of materials and energy in transportation construction, 2:41683 (PB—253713)

Trinecke Zelezarny (Czechoslovakia)
Uses of nuclear energy in metallurgy - research and development, 2:41452 (TRINEC-P—926)

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U

UKAEA Research Group, Abingdon. Culham Lab.
Confinement studies in Culham stellarators with ohmic heating currents, 2:42211 (AED-Conf—76-506-008)
Filling of toroidal traps with laser plasmas, 2:42301 (AED-Conf—76-506-003)

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Possible use of carboxylic acids for U/Pu separation in nuclear fuel reprocessing, 2:41090 (AERE-R—8509)

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Statement of C.D. Zerby before the California Energy Resources Conservation and Development Commission, Sacramento, California, March 21, 1977, 2:41143 (Y/OWI/TM—22)

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Study of cost/benefit tradeoffs for reducing the energy consumption of the commercial air transportation system, 2:41607 (N—76-31079)

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Assessment of very high-temperature reactors in process applications. Appendix III. Engineering evaluation of process heat applications for very-high temperature reactors, 2:40788 (ORNL/TM—5411)

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Braze ring qualification program, 2:41506 (UNI—187(Rev.1))

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Cost/benefit trade-offs for reducing the energy consumption of commercial air transportation (RECAT). Final report, 2:41605 (N—76-28203)
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Plasma core reactor simulations using RF uranium seeded argon discharges, 2:41454 (N—76-30046)

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Local hydrodynamic characteristics of regular triangular lattice of rods, 2:41458 (UJV—3778-R)

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Summary of space imagery studies in Utah and Nevada, 2:42142 (E—76-10420)

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V

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Vermont Yankee Nuclear Power Station. Annual operating report: January—December 1976, 2:41431 (DOCKET-50271—917)

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Nonlinear analysis of laminated fibrous composites, 2:41861 (N—76-27359)

W

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Baseline study program, North Puget Sound. Biological oil impact literature review. Volume I. Text. Final report, 2:40987 (PB—254291)
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Increasing the efficiency of azide mutagenesis in barley, 2:42043 (RLO—2221-T2-31)
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Assessing the relationship between urban form and travel requirements: a literature review and conceptual framework. Research report, 2:41687 (PB—254988)
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Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.
Clinch River Breeder Reactor Plant. Appendix A. Flow diagram for the VARR II program, 2:41351 (CRBRP-ARD—0106(Vol.2))
Clinch River Breeder Reactor Plant. Appendix B. FORTRAN IV index listing of the VARR II program, 2:41381 (CRBRP-ARD—0106(Vol.3))
Core restraint development. Quarterly progress report for period ending November 30, 1976, 2:41407 (WARD-CR—3045-15)
Fuel-cladding mechanical interaction effects in fast reactor mixed oxide fuel, 2:41408 (WARD-OX—3045-28)
Radial blanket design and development. Quarterly progress report for period ending May 31, 1976, 2:41409 (WARD-RB—3045-14)
Westinghouse Hanford Co., Richland, Wash. (USA)
Caustic stress corrosion cracking, 2:41388 (HEDL-SA—1122)
Westinghouse Research Labs., Pittsburgh, Pa. (USA)
Assessing the potential for optimal utilization of off-peak power. Volume I. Executive summary. Final report, 2:41650 (PB—254774)
Assessing the potential for optimal utilization of off-peak power. Volume II. Electrical loads offering major potential for the use of off-peak power. Final report, 2:41651 (PB—254775)
West Virginia Dept. of Natural Resources, Charleston (USA)
Contribution of ERTS-B to natural resource protection and recreational development in West Virginia. Progress report No. 3, 19 Mar—19 Jun 76, 2:40853 (E—76-10445)
West Virginia Univ., Morgantown (USA). Dept. of Industrial Engineering
Use of an interactive energy model for technology assessment with special reference to underground coal gasification, 2:40790 (PB—255543)
West Virginia Univ., Morgantown (USA). Water Research Inst.
Physiological effects of sublethal levels of acid water on fish, 2:42122 (PB—253958)

Y

Yardney Electric Corp., Pawcatuck, Conn. (USA)
Development and fabrication of large vented nickel—zinc cells. Final report, 2:41568 (N—76-28642)
Fabrication and testing of sealed silver—zinc cells. Final report, 2:41572 (N—76-27673)

AUTHOR INDEX

Authors' surnames are indexed in the form appearing in the abstracted publication; given names are reduced to initials. Each author entry gives the publication title and the citation number. Report numbers, if applicable, are given in parentheses at the end of the entry. For publications with multiple authors, an author entry is provided for each. Entries for the second and succeeding author give a reference to first author.

Because of problems involved in the mechanical preparation of this index, all accent marks are omitted. Changes in spelling introduced as a result of accent omission follow standard conventions.

A

Abad, B.P., *See* Farouq, S.M., 2:41050
Abdel-Moneim, M.T., Two-dimensional transient flow analysis of a pipe-elbow loop by finite-differences, 2:41459
Abdou, I.K., *See* Aboul-Gheit, A.K., 2:40951
Abdulrahman, H.O., ISA: Ineractive Stress Analysis. A program for plane stress, plane strain and axisymmetric analysis of structural continua. User's manual, 2:41472 (ORNL/Sub/4164—2)
Aboul-Gheit, A.K., Hydrodenitrogenation of petroleum-model-nitrogen compounds, 2:40951
Abrahams, C.D., *See* Parks, N.J., 2:42090
Abrams, M., Temperature distribution along an absorbing-emitting fluid layer flowing over an opaque substrate, 2:41230
Abrao, A., *See* Gonzaga, M., 2:41076
Abrosimov, B.Z., *See* Sycheva, A.M., 2:40944
Aburomia, M.M., Heat transfer in tube bundles of heat exchangers with flow baffles induced forced mixing, 2:41418
Adams, A.A., Research on electrochemical energy conversion systems. Final technical report, 1 Jul 1975—30 Jun 1976, 2:41663 (AD-A—034454)
Adams, S.M., Critical evaluation of the nonradiological environmental technical specifications. Volume 3. Peach Bottom Atomic Power Station Units 2 and 3, 2:41494 (ORNL/NUREG/TM—71)
Adar, J., Near term feasibility of nuclear reactor for sea-water desalting: coupling of standard condensing nuclear power stations to low grade heat multieffect distillation plants, 2:41447 (IAEA-CN—36/52)
Adcock, J.B., *See* Haut, R.C., 2:41164
Addicott, G.W., *See* Kroenke, W.C., 2:41477
Adelman, S.J., *See* Underhill, A.B., 2:42155
Adrianov, M.A., *See* Chebotarev, N.T., 2:41765
Advani, S.A., *See* Shoemaker, H.D., 2:40815
Advani, S.H., Design criteria for hydraulic fracturing of coal beds, 2:40813 (MERC/SP—76/3, pp 295-299)
Thermo-viscoelastic considerations associated with underground coal gasification, 2:40765 (MERC/SP—76/3, pp 266-271)
Aerov, M.E., Operation of primary fractionation tower in unit for pyrolysis of liquid hydrocarbons, 2:40943
Afanas'ev, N.A., *See* Gridin, I.D., 2:41173
Agapova, N.P., *See* Zaimovskii, A.S., 2:41444
Agarwala, G.C., *See* Kondal Rao, N., 2:41086
Agrawal, A.K., Preaccident modeling of an LMFBR plant for SSC-L, 2:41509 (BNL-NUREG—50602(Pt.1))
Agrawal, B.B., Nature and distribution of sulphur compounds in Darius crude, 2:41017
Agroskin, A.A., *See* Svyatets, I.E., 2:40820
Agterberg, F.P., Geomathematical prediction of sulphur in coal, New Lingan Mine area, Sydney coalfield, 2:40867
Aharonson, E.F., Air pollution and the lung, 2:42127
Ahlstrom, H.G., Plasma experiments with 1.06-μm lasers at the Lawrence Livermore Laboratory, 2:42308 (UCRL—77943(Rev.2))
Akhmedov, R.B., Process of combustion of a mixture of natural, coking, and blast-furnace gases in a reversible combined burner with controlled spray, 2:41031
Al'perovich, V.Ya., Determination of the rate of chemosorption of oxygen by coals, 2:40819
Albersheim, P., *See* Labavitch, J.M., 2:42036
Albrecht, W., *See* Meier, H.U., 2:41664
Alcone, J.M., *See* Alvis, R.L., 2:41224
Alcorn, W.R., *See* Hillenbrand, L.J., 2:40795
Alders, C.A., Study of earth-covered buildings by an electric utility company, 2:41613 (NSF-RA—760006, pp 107-115)
Aleksandrov, A.P., Structure of atomic power industry with allowance for energy production other than electricity, 2:41438 (IAEA-CN—36/337)
Uranium-graphite reactor development in the USSR, 2:41360 (IAEA-CN—36/586)
Aleksandrov, B.A., *See* Korshunov, A.N., 2:40883
Aleksandrov, I.V., Investigation of the organomineral compounds of brown coals by the ESR method, 2:40830
See Burkov, P.A., 2:40821
Alertmann, B., Nuclear power plant at Biblis, 2:41337
Alexander, C.A., Fabrication and high temperature thermodynamic and transport properties of PuN, 2:41838
Alexander, J.K., Terrestrial kilometric radiation: 2-emission from the magnetospheric cusp and dayside magnetosheath, 2:42191 (N—76-27752)
Alexander, K.F., Prospects and technical problems of nuclear fusion, 2:42274
Alexas, A., Measurements of the electrical resistance of UO_2-pins at high temperatures, 2:41851
Alfven, H., Energy policy and public acceptance, 2:41493 (IAEA-CN—36/588)
Alikaev, V.V., Plasma heating in the TM-3 Tokamak at the electron cyclotron resonance in magnetic fields up to 25kGs, 2:42214 (EUR-CEA-FC—855-TR)
Allen, B.J., *See* de Musgrove, A.R. L., 2:42204
Allen, J., Development of compound parabolic concentrators for solar thermal applications, 2:41231
Allen, P.B., *See* Butler, W.H., 2:41810
Allen, R.P., Microstructure and kinetics of the plutonium βyieldsα and γyieldsα tranaformations, 2:41761
Sputter-deposition of metastable Ta-Pu, Ag-Pu and Co-Pu alloys, 2:41759
Allen, S.J., *See* Johnson, C.C., 2:42135
Allred, J.W., Inexpensive economical solar heating system for homes, 2:41204 (N—76-27671)
Alsup, S., *See* Schmidt, B., 2:41740
Altmann, W., Systematic design strategies and process diagnostics for power plants, 2:41249
Alvis, R.L., Solar powered irrigation system. Quarterly progress report to ERDA/DSE, 2:41224 (SAND—76-0358)
Amano, H., *See* Miyanaga, I., 2:41115
Amanuma, T., Plutonium utilization in thermal and fast reactor in Japan, 2:41303 (IAEA-CN—36/162)
See Muto, T., 2:41489
Amato, R.V., *See* Wier, C.E., 2:40869
Ambrose, J.R., *See* Kruger, J., 2:41812
Amos, D.E., CDC6600 subroutine for normal random variables, 2:42329 (SAND—77-0612)
Anand, R.K., Economical removal of sodium water reaction products (SWRP) from an LMFBR intermediate heat transport system (IHTS), 2:41417
Andersen, A.C., Fractionated x-irradiation damage to developing ovaries in the

bonnet monkey (Macaca radiata), 2:42080 (UCD—472-123, pp 50-52)
Morphologic and hormonal aspects of the estrous cycle in the dog: a review, 2:42063 (UCD—472-123, pp 45-49)
See Chrisp, C.E., 2:42079
Anderson, A.L., LLL plutonium lung counter calibration and discussion of errors, 2:42105 (BNWL—2088, pp 133-149)
See Campbell, G.W., 2:42112
Anderson, J.C., Inelastic response of nuclear piping subjected to rupture forces, 2:41541
Anderson, J.D., *See* Hansen, L.F., 2:42290
Anderson, P.W., *See* Inkson, J.C., 2:42209
Anderson, R.F., *See* Conser, R.E., 2:40981
Anderson, T.L., *See* Pan, Y.S., 2:41473
Ando, Y., *See* Aoki, S., 2:41889
Andoienko, R.A., *See* Rastorguev, Yu.L., 2:40965
Andrastek, D.A., Study of short-haul aircraft operating economics. Phase 2: an analysis of the impact of jet modernization on local service airline operating costs. Final report, 2:41738 (N—76-29188)
Andreeva, R.I., Contemporary structure of the Lower permian sedimentary strata of the Dnieper-Donets depression, 2:40927
Andresen, R.D., Gas scintillation proportional counter for x-ray astronomy, 2:41928 (N—76-27550)
Andrews, S.C., Impact of non-point pollution control on western Lake Superior. Red clay project-work plan. Work plan report May 74—Dec 78, 2:42009 (PB—255 293)
Andreychek, T.S., *See* Novendstern, E.H., 2:41422
Andrzejewski, S., Consequences of the energy crisis, 2:41631
Angelini, A.M., Contribution of nuclear energy to the meeting of Italy's electric power requirements, 2:41308 (IAEA-CN—36/464)
Antal, J., *See* Kalmar, I., 2:41751
Aoki, S., Research and development of spent fuel shipping casks and the criteria for seagoing vessel carrying casks, 2:41889 (IAEA-CN—36/155)
Safety aspects and operating experience of LWR plants in Japan, 2:41526 (IAEA-CN—36/544)
Appelt, K.D., Fuel rods vibration in fast breeder reactors, 2:41382 (CS-INIS—29)
Applebaum, D.C., *See* Mallozzi, P.J., 2:42312
Appleton, D.A., Thermal vacuum accelerated life test of the unit qualification model msds 3 marconi low speed mechanism, 2:41185 (N—76-27586)
Araki, M., Analysis of total pump-turbine system including pipelines, 2:41177
Araktingi, Y.E., Determination of trace metals in crude oils by nonflame atomic absorption spectroscopy, 2:41014
Arcelli, G., Italian progress on LWR fuel design, manufacturing, testing and management, 2:41331 (IAEA-CN—36/310)
Aref'ev, O.A., *See* Gulyaeva, N.D., 2:40832
Ariemma, A, *See* Arcelli, G., 2:41331
See Mangiagalli, D., 2:41320
Arko, A.J., de Haas-van Alphen effect in URh_3 and UIr_3, 2:41762
Arkuszewski, J., Automation of main wheel transport exemplified on Staszic colliery, 2:40887
Arledge, K.W., *See* Trijonis, J.C., 2:41971
Armandillo, E., *See* Spalding, I.J., 2:42301
Armstrong, J.A., *See* Sorokin, P.P., 2:41912
Arndt, C.R., Simulation of spray canal cooling for power plants--performance and environmental effects, 2:41484
Arnold, W.H. Jr., Safety considerations of PWR's, 2:41524 (IAEA-CN—36/512)
Arp, V.D., *See* Clark, A.F., 2:41885
Arrowsmith, H.W., *See* Allen, R.P., 2:41761
Arscott, R.L., *See* Bidlack, D.L., 2:40757
Artman, J.O., Ab initio calculations of the crystal field splittings for Np^{3+} centers in CaF_2 (as well as for selected other complexes) by molecular orbital techniques, 2:41823
Arzamastsev, D.A., Models for analyzing and forecasting economic characteristics of steam power plants, 2:41275
Assmann, H., Thermal creep of UO_2 and UO_2-PuO_2 in the stress range between 40 and 100 N/mm^2, 2:41836
Astrakharchik, G.F., *See* Demirkhanov, R.A., 2:42256
Atkins, R.J., *See* Minushkin, B., 2:41421
Atkinson, D.W., Confinement studies in Culham stellarators with ohmic heating currents, 2:42211 (AED-Conf—76-506-008)
Atumo, H., *See* Yuhara, S., 2:41794
Augenstein, D.C., Investigation of converting the product of coal gasification to methane by the action of microorganisms: Phase I. Third quarterly report, May 1, 1976—August 1, 1976, 2:41169 (FE—2203-12)
Averina, M.V., Investigation of the dependence of the properties of carbonaceous materials on the structure of a petroleum coke filler, 2:40960
Avery, R., *See* Roake, W.E., 2:41512
Ayres, P.S., *See* Van Der Sluys, W.A., 2:41783
Azevedo, J.W., Health effects of pollutants associated with fossil-fuel power generation, 2:40862 (UCD—472-123, pp 122-124)

B

Babkin, R.L., Method of determining the suitability of a solid fuel for storage, 2:40909
Bachilo, L.L., *See* Markov, N.M., 2:41257
Bader, S.D., Inelastic neutron scattering studies of the phonon spectra of Chevrel phase superconductors, 2:41808
Bagger, C., *See* Knudsen, P., 2:41487
Bahar, L.Y., Matrix exponential approach to dynamic response, 2:41542
Bailes, P.J., Liquid—liquid extraction in the petroleum and petrochemical industry, 2:40971
Bailly, J., European in-pile investigations on fast breeder reactor safety, 2:41519 (IAEA-CN—36/245)
Bain, A.S., *See* Fanjoy, G.R., 2:41368
Bairiot, H., Performance and reliability of LWR fuel, 2:41317 (IAEA-CN—36/475)
Bajkov, I.S., Plasma anomalous heating by a strong electromagnetic field, 2:42219
Bakaushin, V.Ya., *See* Kondrat'ev, A.A., 2:40942
Baker, C.C., Review of the conceptual design of a Doublet fusion experimental power reactor, 2:42282
Baker, L. Jr., Postaccident heat removal--1. heat transfer within an internally heated, nonboiling liquid layer, 2:41549
See Faw, R.E., 2:41550
Bakumenko, O.D., Physical characteristics of fast power reactor fuel and their effect on the fuel cycle, 2:41396 (IAEA-CN—36/326)
Balakrishnan, M.R., *See* Mehta, S.K., 2:41370
Balanis, C.A., *See* Holmes, J.J., 2:40761
Balashov, A.A., *See* Nechaev, L.V., 2:41719
Ballagny, A., *See* Moreau, C., 2:41084
Balloffet, Y., *See* Delpeyroux, P., 2:41394
Balph, D.F., *See* Ellis, L.C., 2:42057
Balthesen, E., *See* Lotts, A.L., 2:41359
Balu, K., *See* Thomas, K.T., 2:41123
Balukova, V.D., *See* Spitsyn, V.I., 2:41139
Balykina, G.V., *See* Aerov, M.E., 2:40943
Bangerter, C.D., Pulsed magnetohydrodynamic program. Final report 2 Jan 72—31 Mar 76, 2:41658 (AD-A—028323)
Barabas, K., Experimental study of utilization of nuclear power heating plants for big towns and industrial agglomerations in Russia, 2:41451 (IAEA-CN—36/465)
Baranov, A.Yu., *See* Kapshukov, I.I., 2:41857
See Sudakov, L.V., 2:41834
Barber, P.W., *See* Johnson, C.C., 2:42135
Barbour, B.H., *See* Payne, J., 2:42061
Barbur, I., Co-operation of the CMEA member countries in the developing power reactors of various types, including some aspects of their nuclear fuel cycles, 2:41301 (IAEA-CN—36/6)
Barchenkov, A., *See* Barbur, I., 2:41301
Barkenbus, J.N., Nontechnical issues associated with LMFBR energy centers, 2:41604 (ORAU/IEA(M)—76-15)
Barker, L.K., Catalytic reforming of hydrogenated shale-oil naphtha, 2:41054
Refining improvement of shale-oil naphtha, 2:41053
Barnett, C.F., Atomic data for controlled fusion research, 2:42231 (ORNL—5206(Vol.1))
Barnett, J.P., *See* Kusuda, T., 2:41211
Barnyakova, T.A., *See* Levin, I.S., 2:40809
Baron, J.M., *See* van Zant, G.E., 2:42070
Barrero, A., *See* Sanmartin, J.R., 2:42306
Barringer, S.R., *See* Allred, J.W., 2:41204
Barry, R.E., *See* Arndt, C.R., 2:41484
Bartel, L.C., *See* Beckham, L.W., 2:40759
Bartlett, D.V., Study of far-infrared Michelson interferometry based on fast plasma scanning, 2:42228
Bartlit, J.R., Environmental impact assessment of cooling towers, 2:41499
Barton, D.B., Preferential adsorption in the lubrication process of zinc dialkyldithiophosphate, 2:41009
Barton, G.B., *See* Funk, C.W., 2:41388
Baschek, H., Operational experience with heat exchangers in nuclear power stations with light water reactors, 2:41480
Basov, N.G., Dolphin high-power 12-channel laser unit for spherical heating of thermonuclear targets, 2:42221
Bass, M., Evaluation of Nd:YVO_4 and Ho:Er:Tm:YVO_4 as pulse pumped q-switched lasers. Final report, 1 Jan 1974—1 Apr 1975, 2:41894 (AD-A—029916)
Basu, B., Transport processes and instabilities in magnetically confined plasmas with Tsub(itau) approximately Tsub(etau), 2:42234 (AED-Conf—76-506-023)
Basu, S., Model of equatorial scintillations from in situ measurements. Environmental research papers, 2:42175 (AD-A—027041)
Study and analysis of total electron content and scintillation data. Report for 1 Jul 1975-30 Jun 1976, 2:42179 (AD-A—034490)

See Basu, S., 2:42175
Bates, R.C., *See* Stears, J.H., 2:40880
Battistini, G., Italian nuclear activities in 1974, 2:41311
Baturov, B.B., Nuclear steam superheat results and current prospects, 2:41358 (IAEA-CN—36/325)
Use of nuclear reactors for central heat supply and district heating, 2:41449 (IAEA-CN—36/338)
Baum, V., Energy in developing countries: prospects and problems, 2:41628 (IAEA-CN—36/581)
Bazin, J., *See* Dolle, L., 2:41497
Bean, J.W., *See* Kusuda, T., 2:41211
Beane, F.O., *See* Stephens, D.R., 2:40749
Beard, S.G., Some observations from temperature measurements on recent underground coal gasification experiments, 2:40769 (MERC/SP—76/3, pp 328-338)
Beauchamp, W.T., *See* Mckenney, D.B., 2:41233
Beavers, W.M., *See* Douglas, G.W., 2:40747
Beck, W., Literature search on slip and entrainment in a reactor cooling channel, 2:41531 (IKE—2-33)
Becka, J., Thermal strain effect of welding on the properties and stress state of welded joints in the pressure vessel of the A 1 reactor, 2:41374 (VR—688/76)
Becker, R.H., X-ray emission from the supernova remnant G287.8-0.5, 2:42157 (N—76-27135)
Becker, R.L., *See* Martin, T.G. III, 2:42075
Beckham, L.W., Remote monitoring of an in situ coal gasification process, 2:40759 (MERC/SP—76/3, pp 214-225)
Beckman, R.J., *See* Tietjen, G.L., 2:42327
Beckurts, K.H., Gas-cooled high temperature reactor: perspectives, problems and programmes, 2:41356 (IAEA-CN—36/94)
Beech, J.C., Experimental apparatus to study forced convection heat transfer to supercritical cryogenic hydrogen, 2:41165 (N—76-30504)
Beeson, J.L., *See* Duncan, D.A., 2:40794
Beglinger, R.E., Effect of energy shortage and land use on automobile occupancy rate. Research report, 2:41685 (PB—254921)
Behnam, J., *See* Beglinger, R.E., 2:41685
Beitscher, S., Nonlinear compliance curves caused by crack closure in fracture tests of tungsten alloy, 2:41786
Plane strain fracture toughness of unalloyed alpha phase plutonium, 2:41089
Bel'kevich, P.I., Tasks of scientific investigations in the field of waxes and accompanying products, 2:40803
Belaventsev, L.P., *See* Miller, Yu.A., 2:40816
Belikov, V.S., Plasma thermonuclear cyclotron-magnetoacoustic instability, 2:42248
Bell, C.R., *See* Galluzzo, N.G., 2:41413
Bell, H.H., *See* Fisher, D.K., 2:41938
Belokon, V.G., *See* Bychev, M.I., 2:40826
Belyanin, Yu.I., *See* Lopachenok, L.V., 2:41066
See Proskulryakov, V.A., 2:41067
Ben-David, A., *See* Aharonson, E.F., 2:42127
Bender, F.E., Solar energy applications in agriculture: potential, research needs, and adoption strategies, summary and recommendations, 2:41217 (PB—255928)
Benedetti, G.A., Equations of motion for a mass particle elastically mounted on a disk subjected to transverse and rotational accelerations, 2:41879 (SAND—76-8262)
Benesh, F., Growth effects of major land use projects. Volume II. Compilation of land use based emission factors. Final report, 2:41997 (PB—255302)
Benesh, F.H., Growth effects of major land use projects: Volume III. Summary. Final report, 2:41970 (PB—256204)
Benn, T., Dinorwic power station, 2:41564
Bennett, D.J., University of Minnesota book store, 2:41614 (NSF-RA—760006, pp 117-130)
Bennett, G.L., *See* Murley, T.E., 2:41530
Bennett, J.A., *See* Sturgeon, R.F., 2:41681, 2:41682
Bentrup, F.K., Mine surveying and rock bursts prevention at 'bergbau '76', 2:40895
Berber, J.S., Low-temperature lignite tar: processing and utilization, 2:40812
Berding, K.L., *See* Azevedo, J.W., 2:40862
See Book, S.A., 2:42066, 2:42091
Berestka, A., Method of structure investigation and deposits research by means of boreholes drilled in circle pattern, 2:40921
Bergenlid, U., *See* Mogard, H., 2:41520
Berger, D., Finite element approach to the computation of the MHD spectrum of straight noncircular plasma equilibria, 2:42239
Berger, R.L., *See* Chen, L., 2:42246
Bergman, L., An energy demand model for the Swedish residential heating sector, 2:41675 (PB—256202)
Bergstrom, L.A., High voltage dc transmission applications offshore, 2:41297
Berkowitz, N., *See* Nishida, S., 2:40844, 2:40845
Berkut, M.K., Response of gonadectomized mice to erythropoietic stimulation, 2:42029
See O'Shea, M.D., 2:42031
See Walmer, D.K., 2:42030
Berman, D.A., Indexing the degree of hydrogen embrittlement of 4340 steel using the barnacle electrode. Progress report, 2:41811 (AD-A—034661)
Berman, L.B., Analysis of the reliability of the results of calculation of gas reserves by the volumetric method, 2:41032
Bernard, C., *See* Dolle, L., 2:41497
Berne, T.V., *See* Payne, J., 2:42061
Bernhardt, P.A., Response of the ionosphere to the injection of chemically reactive vapors, 2:42183 (N—76-28719)
Berrie, P.G., *See* Ohse, R.W., 2:41845
Berryman, R.G., High-toughness titanium alloy development. Final engineering report Jan 1975—May 1976, 2:41756 (AD-A—030274)
Bertch, R.W., *See* McFarland, A.R., 2:42119
Bertolacini, R.J., *See* Brooks, J.A., 2:40796
Bertsch, O.L., Three-dimensional finite element analysis of a steam generator channel-head-complex: comparison of theory and experiment, 2:41475
Best, D.A., Diffusion effects in catalytic gas oil cracking, 2:40955
Betten, P.R., *See* Desaulniers, W.E. Jr., 2:41419
Beutler, B., *See* Rosenberg, D.G., 2:40990
Bezborodov, A.I., *See* Mizernyuk, G.N., 2:41746
Beznosikova, A.V., *See* Chebotarev, N.T., 2:41766
Bhaduri, A.K., *See* Shah, B.L., 2:40868
Bhatia, P.K., *See* Maheshwari, S.L., 2:42252
Biancheria, A., *See* Boltax, A., 2:41408
Bibilashvili, Yu.K., *See* Zaimovskii, A.S., 2:41444
Bidlack, D.L., Economics of manufacturing synthesis gas produced by underground coal gasification, 2:40757 (MERC/SP—76/3, pp 179-187)
Bielefeld, M.J., *See* Trombka, J.I., 2:42149
Bienert, W.B., Heat pipe central solar receiver. Semiannual progress report, March 1, 1976—August 31, 1976, 2:41201 (COO/2839—1)
Bierman, A.H., *See* Fisher, G.L., 2:41983
Biermann, W., *See* Michel, A., 2:41403
Biewinga, D.T., *See* Koefoed, O., 2:42144
Bigelow, J., *See* Grundl, J.A., 2:41154
Bilek, V., Some problems of the safety of PWR nuclear power plants viewed from the technical standpoint, 2:41523 (IAEA-CN—36/467)
Billheimer, J.W., Macroanalysis of the implications of major modal shifts in integrated regional transportation networks. Final summary report on phase 1, 2:41686 (PB—254923)
Macroanalysis of the implications of major modal shifts in integrated regional transportation networks. Final report on phase I, 2:41701 (PB—256136)
Macroanalysis of the implications of major modal shifts in integrated regional transportation networks. Phase I: appendices. Final report, 2:41702 (PB—256137)
Billmayer, H., Study of low coal canopy concepts. Final Report, 17 Jun 1974—20 Feb 1975, 2:40872 (PB—254301)
Billmayer, H.J., Development of protective canopy concepts for underground rail haulage equipment. Research report, 2:40873 (PB—254504)
Bird, D.K., Geology and geochemistry of the Dunes Hydrothermal System, Imperial Valley of California, 2:41241 (PB—258098)
Birkhofer, A., Analysis of loss of coolant accidents, 2:41515 (IAEA-CN—36/127)
Birkholz, U., *See* Naegele, J., 2:41842
Birkle, A.J., Experience focuses attention on details of in-service inspection in nuclear plants, 2:41481
Birnbaum, G., Infrared spectroscopic measurements and analysis. Final report, Jan 1975—Mar 1976, 2:42194 (N—76-30320)
Birss, E.W., Set Theoretic Data Structures (STDS): a tutorial, 2:42339 (UCID—17378)
Bishop, E.C., Radial blanket design and development. Quarterly progress report for period ending May 31, 1976, 2:41409 (WARD-RB—3045-14)
Bishop, J.F.W., Fast reactor fuel design and development, 2:41391 (IAEA-CN—36/64)
Bishop, W.P., Goals, objectives and criteria for the management of nuclear wastes: rethinking the problem, 2:41127 (IAEA-CN—36/511)
Bissett, L.A., *See* Shuck, L.Z., 2:40750, 2:40779
Bittermann, D., Reliability analysis of the decay heat removal system of a 1000-MW(e) gas-cooled fast breeder reactor, 2:41425
Blackmer, A.M., Nitrogen isotope discrimination in denitrification of nitrate in soils, 2:41995
Blais, R.N., Use of LARS system for the quantitative determination of smoke plume lateral diffusion coefficients from ERTS images of Virginia, 2:41962 (N—76-24681)
Blaisdell, R.E., How nuclear welding differs from other kinds, 2:41330 (CS-INIS—3)
Blanc, P., *See* Zwingelstein, G., 2:42335
Blanchard, P., *See* Delpeyroux, P., 2:41394
Blander, M., *See* Saboungi, M.L., 2:41863

Blandford, G.E., *See* Wang, S.T., 2:40878
Blank, H., Behaviour of mixed monocarbide and -nitride fuel under high power density, 2:41399 (IAEA-CN—36/369)
Blasie, J.K., Direct methods for the analysis of lamellar neutron diffraction from oriented multilayers: a difference patterson deconvolution approach, 2:42020 (BNL—50453, pp III.58-III.67)
Bligh, T., Comparison of energy consumption in earth-covered vs. non-earth-covered buildings, 2:41612 (NSF-RA—760006, pp 85-105)
Blinov, V.A., Evaluation of the limits of radioactive waste disposal into water systems of international importance, 2:41140 (IAEA-CN—36/346)
Block, S.S., *See* Dariage, L.J., 2:40835
Bloembergen, N., Nonlinear laser spectroscopy, 2:41913
Blomeke, J.O., *See* Culler, F.L. Jr., 2:41112
Blomgren, H., *See* Lundegardh, G., 2:42071
Blumenthal, D.L., *See* Ogren, J.A., 2:41978, 2:41979, 2:41980, 2:41981, 2:41982
Bobin, J.L., Laser and controlled thermonuclear fusion--2, 2:42309
Bobo, J.C., *See* Demay, J.N., 2:41292
Bobrovski, G.A., *See* Alikaev, V.V., 2:42214
Bock, H.W., Reactor power control by a dual 305 computer system at Stade nuclear power station, 2:41490
Bock, P., Application of Bremsstrahlung activation analysis to the determination of carbon and nitrogen in sodium, 2:41865 (CEA-CONF—3657)
Bodh, R., *See* Mogard, H., 2:41520
Bodin, L., UCOST: a planning, scheduling, and costing system, 2:41703
Bodrov, I.S., Tests of the gas turbine plant gt-100-750-2 using liquid fuel, 2:41268
Boerresen, S., *See* Rolstad, E., 2:41316
Boers, B.L., *See* Halle, H., 2:41505
Bogatov, G.F., Thermal conductivity of Upper Cretaceous Malgobek crude oil and narrow cuts from this crude, 2:40999
Bogdanov, N.F., Influence of polymeric additives on petroleum wax properties, 2:40969
Bohnsack, G., Importance of phosphate in the system iron/water. II. The chemistry of the system, 2:41817
Boiko, E.A., *See* Bodrov, I.S., 2:41268
Bol, K., *See* Grisham, L.R., 2:42218
Bold, H., Static convertor transformers for the hvdc transmission link Cabora Bassa-Apollo, 2:41298
Boldeman, J.W., *See* de Musgrove, A.R. L., 2:42204
Boldt, E.A., *See* Becker, R.H., 2:42157
See Holt, S.S., 2:42160
See Kaluzienski, L.J., 2:42158
Boltax, A., Fuel-cladding mechanical interaction effects in fast reactor mixed oxide fuel, 2:41408 (WARD-OX—3045-28)
Bolton, R., *See* Drouet, M.G., 2:42244
Bond, A.H. Jr., *See* Rundberg, R., 2:42201
Bonnelle, C., Analysis of the α-Pu 5f electron distribution by X-ray emission spectroscopy, 2:41763
Study of the modification of the 5f states in the α and delta-plutonium phases by X-ray absorption spectroscopy, 2:41764
Book, S.A., Age-related changes in thyroid function in beagle pups, 2:42066 (UCD—472-123, pp 114-115)
Dose limitations to humans from ^{129}I, 2:42086 (UCD—472-123, pp 120-121)
^{131}I metabolism in pregnant and fetal guinea pigs, 2:42091 (UCD—472-123, pp 111-113)
Metabolism of ^{129}I in young beagles, 2:42092 (UCD—472-123, pp 116-117)
See Azevedo, J.W., 2:40862
Booth, R.S., Noise diagnostics for safety assessment. Quarterly progress report for October—December 1976, 2:41321 (ORNL/NUREG/TM—97)
Bordeaux, J., Shipboard oil-in-water monitor. Final report 24 May 74—30 Jun 76, 2:40983 (AD-A—028785)
Borio, R.W., Laboratory analysis of solvent refined coal. Technical report No. 1, 2:40801 (PB—255550)
Solvent refined coal evaluation: pulverization, storage, and combustion. Technical report No. 2, 2:40802 (PB—2557029)
Borisov, A.V., New oil and gas exploration and prospecting directions in the Upper Pechora depression of the pre-Ural trough, 2:40925
Borner, G., *See* Chandra, P., 2:42042
Bornstein, M.I., *See* Werner, A.S., 2:40979
Borodaev, G.S., *See* Bogatov, G.F., 2:40999
Borodin, B.A., *See* Burkov, P.A., 2:40821
Borrego, J.M., Interface states in Schottky barrier diodes. Interim report, 2:41933 (AD-A—034425)
Bottiglioni, F., Plasma heating by cluster injection: basic features and expected behaviour, 2:42213 (EUR-CEA-FC—848)
Botvinick, E.H., *See* Parmley, W.W., 2:42060
Boudry, J.C., *See* Levallet, E.H., 2:41393
See Miquel, P., 2:41092
Boutard, J.L., Nuclear magnetic resonance of carbon 13 and nitrogen 15 in uranium and thorium carbonitrides, 2:41824
Bouwmeester, R.J.B., *See* Meroney, R.N., 2:41245
Bowman, B.R., Reactor containment analysis for BWR suppression systems. Progress report, October—December 1976, 2:41538 (UCRL—50045-76-4)
Boyarski, A.M., *See* Logg, C.A., 2:42330
Boyd, R.M., Post burn analysis techniques applicable to underground coal gasification, 2:40771 (MERC/SP—76/3, pp 344-353)
See Fischer, D.D., 2:40772
Boyd, T.J.M., *See* Turner, J.G., 2:42263
Boyer, W.B., Electron beam fusion data acquisition program DATAIN (EBD), 2:42319 (SAND—77-0204)
Boyle, M.J., *See* Ahlstrom, H.G., 2:42308
Bozak, R.E., Effects of heat and radiation on Gasbuggy chimney gas, 2:41039
Bozzoni, T., *See* Arcelli, G., 2:41331
Bradley, E., *See* Parks, N.J., 2:42124
Bradley, E.W., *See* Parks, N.J., 2:42090
Bradley, J., *See* Atkinson, D.W., 2:42211
Bradway, R.M., *See* Werner, A.S., 2:40979
Braga, F., *See* De Macedo, M.S., 2:42082
Braid, T.H., *See* Chang, H.H., 2:42202
Brandenburg, C.F., Results and status of the second Hanna in situ coal gasification experiment, 2:40748 (MERC/SP—76/3, pp 36-52)
See Fischer, D.D., 2:40772
Brandt, R.C., Work carried out in France on the design, manufacture, handling and development of nuclear fuel, 2:41334 (IAEA-CN—36/569)
Bratzel, M.P. Jr., Determination of lead in petroleum and petroleum products by atomic absorption spectrometry with a carbon rod atomizer, 2:41013
See Hall, G., 2:41016
Braun, F., *See* Hennig, Th., 2:41265
Brebano, M.C., *See* Goldberg, S.M., 2:41113
Brecht, C.A., International gas transmission, 2:41042
Bremner, J.M., *See* Blackmer, A.M., 2:41995
Brennan, J.K., Improved methods for reducing calcium and magnesium concentrations in tissue culture medium: application to studies of lymphoblast proliferation in vitro, 2:42053
Brennan, M.P.J., Anodic evolution of sulphur from sodium polysulphide melts. I. Voltammetric measurements on planar carbon electrodes, 2:41573
Brenner, R., *See* Rundo, J., 2:42108
Brickhill, J.A., Impact of natural gas curtailments on electric utility plants. Volume I. Text, 2:41033 (PB—258329)
Impact of natural gas curtailments on electric utility plants. Volume II. Schedules, 2:41035 (PB—258330)
Bridges, J.E., EMP preferred test procedures (selected electronic parts). Revision, 2:41934 (AD-A—034791)
Briec, M., *See* Dolle, L., 2:41497
Briggs, G., *See* Minear, R.A., 2:40871
Brigham, W.E., *See* Kuo, M.T., 2:42139
Brockway, C., *See* Schorr, J.R., 2:41977
Broderius, S.J., Effect of hydrogen sulfide on fish and invertebrates. Part II. Hydrogen sulfide determination and relationship between pH and sulfide toxicity. Final report Aug 72—Mar 75, 2:42123 (PB—257246)
Brodskii, E.S., Mass-spectrometric analysis of group composition of saturated petroleum hydrocarbons in crude oil, 2:40968
Brodsky, M.B., *See* Arko, A.J., 2:41762
See Trainor, R.J., 2:41807
Brogan, T.R., *See* Bangerter, C.D., 2:41658
Brooks, J.A., Catalyst development for coal liquefaction. Annual report, 2:40796 (PB—254400)
Brooks, K.M., *See* Ahlstrom, H.G., 2:42308
Brown, C.W., *See* Lynch, P.F., 2:40992
Brown, G.D., Desulfurization of steel mill sinter plant gases. Final report, 2:41976 (PB—261922)
Browning, P., Segregation and vapour pressure studies on the uranium-plutonium-carbon system, 2:41839
Brueckner, G.E., *See* Sturrock, P.A., 2:42165
Brueggemann, H., *See* Gartler, D.J., 2:41714
Brumme, G.D., *See* Ohse, R.W., 2:41845
Brummer, S.B., *See* Rauh, R.D., 2:41579, 2:41580
Brumovsky, M., Irradiation stability of welded joints, 2:41820 (VR—691/76)
Brun-Tsekhovoi, A.R., *See* Stadnik, V.F., 2:40946
Bruzzone, H.A., Possible correlation of the neutron yield to the electromechanic work in Mather-type plasma focus devices, 2:42238
Brynes, R.K., *See* Hamburg, A., 2:42041
Buchanan, J.R., LMFBR safety. 3. Review of current issues and bibliography of literature (1972—1974), 2:41532 (ORNL/NUREG/NSIC—131)
Buchberg, H., *See* McMurrin, J.C., 2:41229
Bucholz, J.A., Direct-coupled-ray method for three-dimensional shielding analysis, 2:41467 (CONF-770401—9)
Budde, H.J., Battery-electric road transport as part of an aggregate transport system, 2:41732
Buder, M.K., Factors influencing the economics of large-scale in situ coal gasification operations, 2:40754 (MERC/SP—76/3, pp 145-154)
Buell, J.W., Baseline study program, North Puget Sound. Biological oil impact literature review. Volume I. Text. Final report, 2:40987 (PB—254291)
Bugnet, B., *See* Doniat, D., 2:41569
Buhrley, L.E., Contractility of rat testicular seminiferous tubules in

vitro: prostaglandin F/sub lα/ and indomethacin, 2:42067
Bujas, R., *See* Moreau, C., 2:41084
Bukowski, A., Improvement of raw materials for catalytic cracking, 2:40948
Bulkin, Yu.M., *See* Baturov, B.B., 2:41449
Bullemer, R., *See* Billheimer, J.W., 2:41686, 2:41701, 2:41702
Bulls, F.B., *See* Gutzeit, J., 2:40952
Burdyuzha, V.V., Powerful galactic masers, 2:42162 (N—76-25116)
Burkhalter, D.E., *See* Kaya, C.M., 2:42115
Burkhardt, L.C., Magnetic energy storage system used in ZT-1, 2:42299
Toroidal Z-pinch demonstration, 2:42277 (LASL—77-3)
Burkhart, L., *See* McCutcheon, E.B., 2:41094
Burkov, P.A., Study of the fire risk of brown coals of the Kharanorskoe deposit, 2:40821
Burlaga, L.F., Interplanetary boundary layers at 1 AU, 2:42174 (N—76-31115)
Burleson, G.R., *See* Edwards, H.E., 2:42037
Burnett, D.S., *See* Switkowski, Z.E., 2:42150
Burnette, G.W., BWR blowdown/emergency core cooling third quarterly progress report, July 1—September 30, 1976, 2:41511 (GEAP—21304-3)
Burrows, J.R., *See* Rossberg, L., 2:42192
Burton, L.C., *See* Haacke, G., 2:41228
Burwell, E.L., *See* Carpenter, H.C., 2:41051
Busch, G., *See* Li, C.H., 2:41757
Bush, T.W., Basic studies of coal pyrolysis and hydrogasification. Quarterly progress report No. 4, 21 Feb—20 May 1976, 2:40743 (PB—254878)
Butkovich, T.R., Calculation of fracture and permeability enhancement from underground explosions in coal, 2:40767 (MERC/SP—76/3, pp 285-294)
Butler, D.L., *See* Grose, L.T., 2:41234
Butler, M.K., Argonne Code Center: compilation of program abstracts, 2:42325 (ANL—7411(Suppl.10))
Butler, W.H., Gas anisotropy and T/sub c/ enhancement: general theory, and calculations for Nb, using Fermi surface harmonics, 2:41810
Buttemer, D.R., *See* Rickard, C.L., 2:41513
Buurman, E., Computer-operated ripple control command unit, 2:41294
Bychev, M.I., Pyrolytic mass spectrometry of coals at low ionizing voltages, 2:40826
Byrd, J. Jr., Use of an interactive energy model for technology assessment with special reference to underground coal gasification, 2:40790 (PB—255543)
Byrer, C.W., *See* Sole, T.L., 2:40855
Byvik, C.E., Photoelectrolytic production of hydrogen using semiconductor electrodes. Interim report, 2:41160 (N—76-24374)

C

Cabanius, J., Nuclear power plant of Tihange, 2:41338
Cabot, T., *See* Martinuzzi, S., 2:41195
Cahn, R.P., Method of utilizing the excess heat of an electricity generating plant, 2:41273
Caines, R.E., Exposure fire protection for floating nuclear power plants, 2:41543
Calais, D., *See* Bonnelle, C., 2:41764
See Charissoux, C., 2:41798
See Zanghi, J.P., 2:41778
Caledonia, G., *See* Taylor, R., 2:41897
Calloway, J.A., *See* Thompson, R.G., 2:41638
Calusaru, A., Chemical and ion exchange unit for a cascade of uranium isotope separation, 2:41081
Camin, D.L., Chromatography in the petroleum industry, 2:41024
Campbell, B.E., *See* Mallozzi, P.J., 2:42312
Campbell, G.G., *See* Humphrey, A.E., 2:40770
Campbell, G.M., Thermodynamic properties of the binary Laves phase compounds of plutonium with the group VIIIa metals, 2:41797
Campbell, G.W., Ultrasonic measurement techniques used at LLL for determining chest wall thickness and organ shapes, 2:42112 (BNWL—2088, pp 219-227)
See Anderson, A.L., 2:42105
Campbell, J.H., Preliminary laboratory and modeling studies on the environmental impact of 'in-situ' coal gasification, 2:40753 (MERC/SP—76/3, pp 119-139)
Campolunghi, F., Burn-out power in once-through tubular steam generators, 2:41410
Candes, P., Safety and radiation protection aspects of the management of radioactive wastes of high level activity, 2:41120 (IAEA-CN—36/231)
Cannon, C.P., Temperature and voltage tests on MgO insulated coaxial cables, 2:41389 (HEDL-TME—76-66)
Cantor, C.J., *See* Basu, S., 2:42179
Capelle, G.A., Cn production efficiencies from active nitrogen-hydrocarbon flames. Interim report, 2:41167 (AD-A—026638)
Capes, C.E., Agglomeration in coal preparation, 2:40739
Bacterial oxidation in upgrading pyritic coals, 2:40740
Rejection of trace metals from coal during beneficiation by agglomeration, 2:40904
Capone, F., *See* Ohse, R.W., 2:41846
Carlile, R.N., Experimental validation of transient plasma effects used in high altitude electromagnetic pulse calculations. Final report, 2:42187 (AD-A—028516)
Carmen, R.L., Array laser: a technique for the generation of ultra-high laser intensities, 2:41902 (LA-UR—75-2260)
Carmichael, H., *See* Shea, M.A., 2:42148
Carnall, W.T., *See* Veal, B.W., 2:41849
Carpenter, H.C., Engineering aspects of processing oil shale by in situ retorting, 2:41051
Carr, J.A., Fast Flux Test Facility. Final report on FFTF outlet plenum buoyancy effects study, 2:41504 (WARD—2171-64)
See Novendstern, E.H., 2:41422
Carroll, B., Rutgers zodiacal light experiment on OSO-6. Final report, 2:42168 (N—76-30257)
Carstarphen, C., Simulating an urban jitney system, 2:41708
Carter, D., Terraset Elementary School, Reston, Virginia, 2:41616 (NSF-RA—760006, pp 135-149)
Carter, H.R., Functional performance of a two-tube helically-coiled once-through steam generator, 2:41342
Carteret, Y., *See* Delpeyroux, P., 2:41394
Casarett, G.W., Biological effects of low levels of radiation exposure, 2:42077 (UR—3490-1072)
Casey, D.F., *See* Lee, Y.J., 2:41420
Caspar, D.L.D., *See* Kirschner, D.A., 2:42021
Castelli, G.F., *See* Mangiagalli, D., 2:41320
Castle, J., *See* Dhir, V., 2:41554
Castle, R.O., Recent surface movements in the Baldwin Hills, Los Angeles County, California, 2:40937
Catchpole, S., UK experience of planning the nuclear contribution to the UK power programme, 2:41302 (IAEA-CN—36/53)
Catlett, D.S., *See* Fries, R.J., 2:41149
See Mayer, A., 2:41147, 2:41148
Catton, I., *See* Dhir, V., 2:41554
See Harpole, G.M., 2:41546
Caudano, R., *See* Verbist, J.J., 2:41850
Cecille, L., Nuclear transmutation of actinides other than fuel as a radioactive waste management scheme, 2:41133 (IAEA-CN—36/366)
Cervenka, J., *See* Mantlik, F., 2:41458
Chabre, M., Neutron diffraction studies of oriented retinal rods, 2:42022 (BNL—50453, pp III.77-III.85)
Chaiken, R.F., Experimental coal mine fire research, 2:40912 (MERC/SP—76/3, pp 434-451)
In situ combustion of coal for energy: a progress report, 2:40908 (MERC/SP—76/3, pp 96-104)
Chainov, N.D., *See* Orlin, A.S., 2:41712
Chakrabarti, C.L., Evaluation of carbon rod atomizer for routine analysis of vanadium in crude oil by atomic absorption spectroscopy, 2:41012
See Araktingi, Y.E., 2:41014
See Bratzel, M.P. Jr., 2:41013
See Hall, G., 2:41016
Challappa, S., Experience in the manufacture of nuclear equipment in India, 2:41307 (IAEA-CN—36/462)
Chamany, B.F., *See* Mehta, S.K., 2:41370
Chamberlain, A., *See* Bishop, J.F.W., 2:41391
Chambon, M., *See* Redon, A., 2:41119
Chan, S.K., Magnetic ordering and structural transformation in the actinide compounds, 2:41825
Chan, T.K., Slow phase hemolysis in hypotonic electrolyte solutions, 2:42028
Chanana, A.D., *See* Chandra, P., 2:42042
Chandra, P., Quantitation of human T-lymphocytes in blood: use of automatic smearing instrument for preparing fixed slides of E-rosettes, 2:42042
Chandramouli, V.A., *See* Kondal Rao, N., 2:41086
Chang, H.H., Energy dependence of the optical model parameters for α-particles scattered from ^{40}Ca and ^{58}Ni, 2:42202
Chang, H.Y., *See* Advani, S.H., 2:40813
Chang, T.Y., Assessment of non-linear analysis finite element program (NONSAP) for inelastic analysis, 2:41465 (BNL-NUREG—50615)
Chang, Y.W., *See* Abdel-Moneim, M.T., 2:41459
Charissoux, C., Impurity diffusion of cobalt in plutonium, 2:41798
Charrault, J.C., European Community care for nuclear power, 2:41304 (IAEA-CN—36/365)
Chatterjee, S., Predictive criteria for construction/demolition solid waste management. Final report, 2:41690 (AD-A—034419)
Chaudhuri, N.K., Application of fission track registration technique in the estimation of fissile materials. Analysis of plutonium in solutions of complex matrices, 2:41866
Chebotarev, N.T., Crystal structure of the compounds Pu_5X_4 (X=Rh, Ir), 2:41766
Relationship between structure and some properties of delta-Pu and γ-U alloys, 2:41821
Some results of a study of the Pu-Al-Ga phase diagram, 2:41765
Chekalin, N.V., Dye laser probing of primary C_2 radicals formed by ir intense field photolysis of ethylene, 2:41916

Chekunova, E.I., *See* Sycheva, A.M., 2:40944
Chen, F.F., *See* Luhmann, N.C. Jr, 2:42254
Chen, L., Nonlinear saturation of the dissipative trapped-electron instability, 2:42246 (PPPL—1337)
Chen, S.S., Mathematical model for cross-flow-induced vibrations of tube rows, 2:41920
Chenebault, P., *See* Maman, A., 2:41486
Cheng, H., Groupwise rebalancing technique for integral transport problems, 2:41462
Chermanne, J., *See* Vaughan, R.D., 2:41402
Chernukhina, V.G., *See* Aerov, M.E., 2:40943
Chernyaev, V.A., *See* Baturov, B.B., 2:41449
Cherrington, B.E., *See* Crane, J.K., 2:41900
Chertkov, Ya.B., Group composition of sulfur compounds in distillate fuels and method for determining this composition, 2:40967
Service properties of jet fuels in relation to group composition of sulfur compounds in fuel, 2:40963
Chesnutt, J.C., *See* Berryman, R.G., 2:41756
Chikkappa, G.A., *See* Chandra, P., 2:42042
Childers, K., Faraday cup with multiple internal filters and a primary current monitor for characterizing high dose pulsed electron beams. Final report, 2:41924 (AD-A—034613)
Chilton, G.R., Determination of oxygen potentials of hyperstoichiometric U-Pu dioxides in the temperature range 1500-1850 K, 2:41826
Chirkin, N.B., *See* Kapinos, V.M., 2:41918
Chirvinskaya, M.V., *See* Andreeva, R.I., 2:40927
Chmarine, A.A., *See* Alikaev, V.V., 2:42214
Cho, S.M., *See* Aburomia, M.M., 2:41418
Chodzko, R.A., Variable-aperture calorimeter for an unstable resonator. Interim report, 2:41891 (AD-A—026576)
Chrien, R.E., *See* Kopecky, J., 2:42206
Chrisp, C.E., Cumulative mortality in radionuclide treated beagles, 2:42089 (UCD—472-123, pp 94-103)
Development of the chick myoblast culture system for the study of toxicity of fly ash, 2:42121 (UCD—472-123, pp 23-25)
Pathology in a lifespan study of x-irradiated adult female beagles, 2:42079 (UCD—472-123, pp 28-44)
Christens, J.M.A., Two-dimensional calculation of a pulse propagation experiment, 2:41463
Christensen, R.G., *See* Andrews, S.C., 2:42009
Chrusciel, W.A., Design of cryogenic heat exchangers for a superconducting magnet, 2:42296 (ORNL/MIT—242)
Chu, A.W., *See* Aburomia, M.M., 2:41418
Chu, T.K., Conduction heat loss scaling in open field line geometries, 2:42217 (PPPL—1329)
Chulick, E.T., Radiochemical evaluation of Babcock and Wilcox's commercial pressurized water reactor fuel performance, 2:41347
Chung, C.F., *See* Agterberg, F.P., 2:40867
Chung, D.H., Geophysical and geochemical models of the Earth's shields and rift zones, 2:42140 (UCRL—52238)
Chuntu, G.I., *See* Al'perovich, V.Ya., 2:40819
Cicchetti, C.J., The marginal cost and pricing of electricity: an applied approach, 2:41274 (PB—255967)
Cicognani, F., *See* Mangiagalli, D., 2:41320
Ciubotariu, C.D., Relativistic magnetohydrodynamics of an accelerating plasma, 2:42240
Clar, M.L., *See* Mills, T.R., 2:41999
Clark, A.F., Characterization of a superconducting coil composite and its components. Interim report, 2:41885 (PB—261709)
Clark, J.W., Assessing the relationship between urban form and travel requirements: a literature review and conceptual framework. Research report, 2:41687 (PB—254988)
Clark, R.B., *See* Alexander, C.A., 2:41838
Clark, S.K., The influence of tire geometry on the rolling efficiency of commercial vehicle tires. Interim report, 2:41688 (PB—262348)
Clarke, R.H., Investigation of the structure of the reaction center in photosynthetic bacteria by optical detection of triplet state magnetic resonance, 2:42035
Clauss, G., Model testing techniques in offshore pipelining, 2:40997
Clement, J.R., Pulse radiolytic investigation of single heme group reduction in human methemoglobin, 2:42072
Clement, M., Measurement of the ion temperature in Petula from the Doppler broadening of impurity lines, 2:42225 (EUR-CEA-FC—862)
Clements, B.R., Texas utilities program status report, 2:40751 (MERC/SP—76/3, pp 86-89)
Cohen, B.I., Non-linear saturation of the dissipative trapped-ion mode by mode coupling, 2:42250
Cohen, M. Jr., Evolution of 5S ribosomal RNA genes in the chromosomes of the virilis group of Drosophila, 2:42049
Cohen, N., Estimation of lung and skeletal burdens of bone-seeking radionuclides in man from in vivo scintillation measurements of the thorax and the head, 2:42107 (BNWL—2088, pp 161-178)
See Laurer, G.R., 2:42111
Cohen, P., Post-critical heat flux fouling by system corrosion products in a model sodium heated steam generator, 2:41423
Colborn, B.L., *See* Scott, W.H. Jr., 2:42208
Coleman, H.J., *See* Dooley, J.E., 2:41021, 2:41022
See Hirsch, D.E., 2:41023
Coleman, R.T., *See* Brown, G.D., 2:41976
Collier, W.D., AFWL Technical Objective Number 4, nuclear systems support. FY 1978. Final report, Jan 1977—Jan 1978, 2:41944 (AD-A—034399)
Colombant, D.G., *See* Manheimer, W.M., 2:42305
Colonna, R.A., Decision-makers guide in solid waste management, 2:41698 (PB—258266)
Coluccio, G., *See* Arcelli, G., 2:41331
Combarnous, M., Thermal methods of hydrocarbon production--3. Hot fluid drive. principles and laboratory research, 2:40933
Cometto, M., *See* Arcelli, G., 2:41331
Condra, G.D., *See* Lacewell, R.D., 2:41586
Conkling, K., *See* Chandra, P., 2:42042
Conlon, T.W., *See* Chang, H.H., 2:42202
Connaughton, C.R., Our nation's crude oil and natural gas recoveries may be increased by numerical simulation, 2:40917
Connors, R.E., *See* Clarke, R.H., 2:42035
Conser, R.E., New tool combats SO_2 emissions, 2:40981
Contor, K.L., *See* Szczuka, A.E., 2:40876, 2:40877
Conway, J.P., *See* Stears, J.H., 2:40880
Conway, L., *See* Bertsch, O.L., 2:41475
Cook, A.J., *See* Logg, C.A., 2:42330
Cook, J.L., Clinch River Breeder Reactor Plant. Appendix A. Flow diagram for the VARR II program, 2:41351 (CRBRP-ARD—0106(Vol.2))
Clinch River Breeder Reactor Plant. Appendix B. FORTRAN IV index listing of the VARR II program, 2:41381 (CRBRP-ARD—0106(Vol.3))
Copeland, G.E., *See* Blais, R.N., 2:41962
Coppi, B., *See* Basu, B., 2:42234
Coqblin, B., *See* Jullien, R., 2:41771
Costa, J., *See* Augenstein, D.C., 2:41169
Costa, L., *See* Levallet, E.H., 2:41393
Costa, M.I., *See* Imakuma, K., 2:41088
Costello, J.M., Management of wastes containing radioactivity from mining and milling of uranium ores in Northern Australia, 2:41124 (IAEA-CN—36/418)
Cottingham, P.L., *See* Barker, L.K., 2:41053, 2:41054
See Frost, C.M., 2:41055, 2:41056
Cottle, R.W., *See* Dantzig, G.B., 2:42331
Cottrell, R.L.A., *See* Logg, C.A., 2:42330
Coulon, P., *See* Delpeyroux, P., 2:41394
Courcon, P., *See* Delpeyroux, P., 2:41394
Courtois, A., *See* Bonnelle, C., 2:41764
Coutant, J., *See* Bottiglioni, F., 2:42213
Couty, Y., *See* Schmitz, F., 2:41847
Covington, P.C., *See* Carstarphen, C., 2:41708
Cowan, A.M., *See* Bender, F.E., 2:41217
Cowan, D.M., Study of continuous face haulage systems. Final report, 2:40899 (PB—255841)
Coykendall, R.E., Study of cost/benefit tradeoffs for reducing the energy consumption of the commercial air transportation system, 2:41607 (N—76-31079)
Cozzarelli, F.A., On the analogy between thermally and irradiation induced creep. Summary report, 2:41818 (AD-A—034885)
Crabtree, G.W., *See* Arko, A.J., 2:41762
Cracknell, A.P., *See* Przystawa, J., 2:41780
Crandall, D.G., *See* Sandifer, C.W., 2:41927
Crane, J.K., Excitation efficiency and energy storage capabilities of high pressure rare gas—metal vapor mixtures. Final report, 2:41900 (COO—2790-2)
Crawford, P.B., *See* Connaughton, C.R., 2:40917
Crawford, W.D., PWR and BWR light water reactor systems in the USA and their fuel cycle, 2:41319 (IAEA-CN—36/566)
Crespi, H.L., *See* Hoppe, W., 2:42027
Cressy, P.J. Jr., Cosmogenic radionuclides in stone meteorites, 2:42173 (N—76-25115)
Cretella Neto, J., *See* Imakuma, K., 2:41088
Creter, C., *See* Li, C.H., 2:41757
Crockett, P.W., Biological effects of laser radiation (a bibliography with abstracts). Report for 1964—Jan 1977, 2:42137 (NTIS/PS—77/0028)
Environmental carcinogens (a bibliography with abstracts). Report for 1964—Nov 1976, 2:42131 (NTIS/PS—76/964)
Cronkite, E.P., *See* Chandra, P., 2:42042
Cross, J.L., Study of operational parameters impacting helicopter fuel consumption, 2:41736 (N—76-28224)
Cruse, H., *See* Rosenberg, D.G., 2:40990
Culler, F.L. Jr., Management of high level waste, 2:41112 (IAEA-CN—36/15)
Cummings, A., Sound transmission in the 180^0 duct bends of rectangular section, 2:41747
Cumo, M., *See* Campolunghi, F., 2:41410
Cunningham, G.W., *See* Roake, W.E., 2:41512
Cunningham, P.A., *See* Adams, S.M., 2:41494
Curry, J.K., *See* Coykendall, R.E., 2:41607
Curtis, H.W., Experience of European irradiated fuel transport - the first four

hundred tonnes, 2:41106 (IAEA-CN—36/69)
Cusson, R.Y., *See* Maruhn, J.A., 2:42199
Czerniejewicz, W., Two decades of natural gas, 2:41037

D

D'Agostino, R., *See* Benesh, F.H., 2:41970
d'Ursel, G., *See* Verbist, J.J., 2:41850
Dabrowski, W., *See* Motriuk, T., 2:40886
Daeunert, U., Status and programme of development of the fast breeder reactor systems in the Federal Republic of Germany, 2:41404 (IAEA-CN—36/497)
Dahlgren, S.D., *See* Allen, R.P., 2:41759
Dalton, C., *See* Huang, C.J., 2:41735
Damien, D., *See* Haessler, M., 2:41864
Damodaran, K.K., *See* Iyengar, P.K., 2:41306
Dandekar, B.S., Improving the global ionospheric predictions of f(o)F2. Air force surveys in geophysics, 2:42177 (AD-A—030741)
Danilov, A.E., *See* Basov, N.G., 2:42221
Dantzig, G.B., Systems Optimization Project. Progress report, 1 October 1975—30 June 1976, 2:42331 (SU—326P18X10)
Dariage, L.J., Use of a flame photometric detector for the analysis of coal sulfur, 2:40835
Dasgupta, R., Nucleotide sequence of a viral RNA fragment that binds to eukaryotic ribosomes, 2:42032
Datta, K.K., *See* Shah, B.L., 2:40868
Datta, R.S., Ammonia injection scheme for fracturing and permeability enhancement of coal beds, 2:40780 (MERC/SP—76/3, pp 467-670)
David, A., Asphaltene flocculation during solvent stimulation of heavy oils, 2:40941
Davies, C., Characterization of naphthalenedicarboxylic acids. I. Ultraviolet absorption spectra, 2:41869
Davis, J.M., Fabrication of a focusing soft x-ray collector payload. Final report, 22 Nov 1972—30 Jun 1976, 2:41929 (N—76-30527)
Davis, J.P., Closed vapor cycle engine operated with trifluorethanol/ammonia as the working fluid, 2:41725
See Nydick, S.E., 2:41247
Davis, R.L., *See* Dunn, W.L., 2:41535
Davis, W., Dewar technology study. Final report, 2:41883 (N—76-27444)
Davydov, E.F., *See* Zaimovskii, A.S., 2:41444
Davydova, Zh.A., Chemical reactions of the paramagnetic centers of coal pitch and the products of the hydrogenation of coals, 2:40831
De Bartolo, G., Methodological survey of energy modeling, 2:41630
de Cruz Filipe, R., Advisability of nuclear energy: analysis from the point of view of the electric generating system, 2:41441
de Figueiredo, R.J.P., Feature extraction techniques for classification and identification of spectral signatures. Technical report, 2:40982 (AD-A—027848)
de Franco, M., Thermodynamic properties of (U,Pu)Osub(2+-x) described by a cluster model, 2:41840
de Kock, J.W., Estimation of some properties of South African coals from proximate analyses, 2:40841
De Macedo, M.S., Control of IgE and IgGl antibody production in mice, 2:42082
de Musgrove, A.R. L., Average neutron resonance parameters and radiative capture cross sections for the isotopes of molybdenum, 2:42204
de Nordwall, J.H., *See* Charrault, J.C., 2:41304
de Novion, C.H., Lattice defects in actinide carbides and their relation to physical properties, 2:41844
Study of atomic short-range order in nonstoichiometric actinide carbides by diffuse neutron scattering, 2:41832
See Boutard, J.L., 2:41824
See Haessler, M., 2:41864
de Vries, J.W., *See* Moers, J.C., 2:41502
Deal, L.J., *See* Kennedy, R.H., 2:41125
DeBruler, M., *See* Butler, M.K., 2:42325
Decaprio, A.R., *See* Davis, J.M., 2:41929
Decicco, J.M., *See* Tate, V.H., 2:42164
Dedjurin, A.J., *See* Gomozov, L.I., 2:41837
Deese, J.E., *See* Hassan, H.A., 2:42195
Deineko, L.S., *See* Kondrat'ev, A.A., 2:40942
Dejonghe, P., Radioactive waste management in Belgium, 2:41117 (IAEA-CN—36/187)
Delafosse, J., *See* Brandt, R.C., 2:41334
Delagare, F., *See* Alertmann, B., 2:41337
Delameter, W.R., Measurement of residual stresses by the hole-drilling method, 2:41880 (SAND—77-8006)
Delhaye, J.M., Summary on experimental methods for statistical transient analysis of two-phase gas-liquid flow, 2:41312 (ANL—76-75)
Dellis, A.N., *See* Atkinson, D.W., 2:42211
DeLozier, R.C., Monte Carlo error analysis of power plant capital cost calculations, 2:41440 (K/CSD—3)
Delpeyroux, P., Characteristics and behaviour of the PHENIX fuel element, 2:41394 (IAEA-CN—36/268)
Delson, J.K., Clean use of coal at the Hadera power station, 2:41280
Demay, J.N., Materials for high voltage cables with polyethylene or chemically cross-linked polyethylene insulation, 2:41292
Demchenko, V.V., Parametric excitation of surface waves by modulated electric HF field, 2:42259
See Grishaev, V.I., 2:42260
DeMeo, E.A., Assessment of cadmium sulfide photovoltaic arrays for large scale electric utility applications. Final report, 2:41199 (PB—255646)
Demidenko, K.A., *See* Kyuregyan, S.K., 2:40964
Demidovich, N.N., *See* Galkin, B.Ya., 2:41132
Demirchyan, Kh.G., *See* Markov, N.M., 2:41257
Demirkhanov, R.A., Investigations of low-frequency oscillations and ion acceleration in a plasma beam discharge, 2:42256
Dempsey, R.M., Development of fuel cell CO detection instruments for use in a mine atmosphere. Summary contract report, 1 Jan 1975—30 Jan 1976, 2:40913 (PB—254823)
Denis, J.M., *See* McColgan, E.C., 2:41062
Dennis, D.M., *See* Lundahl, C.R., 2:41205
Deonigi, D.E., Performance targets for fusion-fission (hybrid) reactors, 2:42272 (BNWL—2139)
Der, J.J., Controllable sorbent broadcaster, 2:40984 (AD-D—003269)
Deramaix, P., *See* Bairiot, H., 2:41317
Derer, J.L., *See* Spedding, F.H., 2:41873
Dergunov, D.M., *See* Korshunov, A.N., 2:40885
DeRock, E.W., *See* Shifrine, M., 2:42087
Derouane, E.G., *See* Verbist, J.J., 2:41850
Desaulniers, W.E. Jr., Structural and thermal-hydraulic design of a sodium heated duplex bayonet tube steam generator, 2:41419
DeShazer, L.G., *See* Bass, M., 2:41894
Deshmukh, B.S., *See* Shah, B.L., 2:40868
Despois, J., Underground storage of heat, 2:41566 (CEA-CONF—3638)
DeTemple, T.A., Excitation and relaxation studies of molecular lasers. Annual report, 15 Feb 1975—14 Feb 1976, 2:41905 (PB—253669)
Deul, M., *See* Moore, T.D. Jr., 2:40881
Devienne, F.M., Isotopic separation by electrostatic filtration, 2:41082
Devitt, T.W., *See* Ponder, T.C. Jr, 2:41278
Dhir, V., Role of Taylor instability on sublimation of a horizontal slab of dry ice, 2:41554
Di Marco, J.N., *See* Burkhardt, L.C., 2:42299
Diaz, N.J., *See* Christens, J.M.A., 2:41463
Dickerman, J.C., *See* Brown, G.D., 2:41976
Dickinson, R.E., *See* Sturrock, P.A., 2:42165
Dicks, J.B., Development program for MHD direct coal-fired power generation test facility. Quarterly technical progress report, July—September 1976, 2:41659 (FE—1760-26)
Dienst, W., Irradiation behaviour of UAlsub(x)-Al dispersion fuels for thermal high flux reactors, 2:41822
Dietrich, F.S., Cross section for the $^{9}Be(n,t_1)^{7}Li$ reaction between 13.3 and 15 MeV, 2:42200
Dietrich, I., Superconducting lenses for high-voltage microscopy. Final report, 2:41884 (N—76-30534)
Dike, R., *See* Burkhardt, L.C., 2:42299
Dillon, R.W., *See* Bender, F.E., 2:41217
Dini, J.W., *See* Johnson, H.R., 2:41919
Dirks, R.A., *See* Sisterson, D.L., 2:41957
Ditman, J.G., Deasphalt to get feed for lubes, 2:40950
Dittbenner, G.R., *See* Freynik, H.S., 2:41941
Dixon, R.H., *See* Elton, R.C., 2:41910
Djordjevic, N.A., *See* McMurrin, J.C., 2:41229
Dmitrovskii, V.I., *See* Berman, L.B., 2:41032
Dobrynin, V.M., Method of determination of abnormally high formation pressures from the data of geophysical investigations of boreholes, 2:40926
Dobson, J.E., Maryland Power Plant Siting Project: an application of the ORNL-Land Use Screening Procedure, 2:41496 (ORNL/NUREG/TM—79)
Dodge, R.N., *See* Clark, S.K., 2:41688
Doggett, R.M., Modeling the economic and environmental consequences of alternative energy policies, 2:41599
Dolgov, V.V., Development of methods for solidification and disposal of fuel cycle radioactive wastes, 2:41122 (IAEA-CN—36/?50)
Dolinskii, G.I., *See* Leonov, O.B., 2:41718
Dolle, L., Tritium formation and elimination in light-water electronuclear plants, 2:41497 (IAEA-CN—36/238)
Dollezhal, N.A., *See* Aleksandrov, A.P., 2:41360
Dolzhikov, V.S., *See* Chekalin, N.V., 2:41916
Domann, H., DUO-bus, supplied either from overhead wire or from battery alternatively, 2:41733
Domke, A.E., *See* Coykendall, R.E., 2:41607
Donaldson, T.P., *See* Spalding, I.J., 2:42301
Doniat, D., Process for producing electric current by the electrochemical oxidation of an active anodic metal, especially zinc, 2:41569
Donnel, C.P.I., Development and fabrication of large vented nickel—zinc cells. Final report, 2:41568 (N—76-28642)

Fabrication and testing of sealed silver—zinc cells. Final report, 2:41572 (N—76-27673)
Donovan, T.J., U.s. geological survey's Project BIRDDOG (basic investigation of remotely detectable deposits of oil and gas), 2:40918
Dooley, J.E., Compound type separation and characterization studies for a 370° to 535°C boiling distillate of Gach Saran, Iran, crude oil, 2:41021
Compound-type separation and characterization studies for a 370° to 535°C distillate of Swan Hills (South Field), Alberta, Canada, crude oil, 2:41022
See Hirsch, D.E., 2:41023
Dorfman, L.M., *See* Clement, J.R., 2:42072
Dortch, M.S., Dickey-Lincoln School Lakes hydrothermal model study; hydraulic laboratory investigation. Final report, Jul 1975—Jun 1976, 2:41557 (AD-A—034538)
Dougherty, M.T., Evaluation of surface mine reclamation techniques. Campbell's Run Watershed, Pennsylvania. Final report, Nov 1970—Oct 1975, 2:40857 (PB—255298)
Douglas, G.W., Feasibility of in-situ coal gasification in the Warrior coalfield; a progress report, 2:40747 (MERC/SP—76/3, pp 18-35)
Downs, W., Investigating storage, handling, and combustion characteristics of solvent refined coal. Task C extension, ball-and-race pulverization and direct firing. Final report, 2:40900 (PB—257551)
Doyle, B.B., *See* Miller, A., 2:42023
Doyle, J.C. Jr., Strip mining in the corn belt: the destruction of high capability agricultural land for strip-minable coal in Illinois, 2:41642
Drahny, M., Research programs in nuclear technology, 2:41439 (INIS-mf—3391, pp 106-116)
Draper, R.G., *See* McColgan, E.C., 2:41059
Drouet, M.G., Spatial correlation between 1.06 μm laser irradiation and emitted current for a plane target, 2:42244
Dua, S.S., Two-dimensional analysis of conduction-controlled rewetting with precursory cooling, 2:41547
Dubin, A.P., *See* Gobetz, F.W., 2:41605
Duesing, G., Full-size vacuum vessel and helical winding for the W VII Stellarator, 2:42297
Dufek, W.L., Fault tolerant, multiplexed control rod position detection and indication system for nuclear power plants, 2:41349
Duffy, T.L., *See* Golchert, N.W., 2:41961
Duncan, D.A., Research and development of rapid hydrogenation for coal conversion to synthetic motor fuels (Riser Cracking of Coal). Third Quarter Report, October 1—December 31, 1976, 2:40794 (FE—2307-13)
Duncastelle, F., Metallurgical properties of metallic alloys in relation to their electronic structure: theoretical aspects and prospective for actinides, 2:41767
Dunlay, J., *See* Nydick, S.E., 2:41247
Dunn, W.L., Tornado missile risk analysis. Topical report No. 1, 2:41535 (PB—254415)
Dunnicliff, C.J., *See* Schmidt, B., 2:41740
Dupouy, J.M., *See* Delpeyroux, P., 2:41394
Durney, C.H., *See* Johnson, C.C., 2:42135
Durran, D.A., *See* Chodzko, R.A., 2:41891
Dyer, C.S., *See* Trombka, J.I., 2:42149
Dyke, J.A., *See* Shifrine, M., 2:42039
Dyne, P.J., *See* Tomlinson, M., 2:41116
Dyrdin, V.V., *See* Tarasov, B.G., 2:40865

E

Eadie, G.G., Report of ambient outdoor radon and indoor radon progeny concentrations during November 1975 at selected locations in the grants mineral belt, New Mexico. Final technical note, 2:41996 (PB—258257)
Eastlack, J.K., *See* Eastwood, D.E., 2:40760
Eastwood, D.E., Real time process monitoring in underground coal gasification, 2:40760 (MERC/SP—76/3, pp 226-237)
Edgar, T.F., Chemical reactor modeling of in situ coal gasification, 2:40764 (MERC/SP—76/3, pp 256-265)
Research on in situ gasification of Texas lignite at the University of Texas, 2:40752 (MERC/SP—76/3, pp 90-95)
Edgington, D.N., *See* Parker, J.I., 2:42005
Edney, C.J., Some UK experience and practice in the packaging ard transport of irradiated fuel, 2:41107 (IAEA-CN—36/70)
Edwards, H.E., Study of Rous sarcoma virus-transformed baby hamster kidney cells using fluorescent probes, 2:42037
Edwards, H.S., *See* Butler, M.K., 2:42325
Edwards, L.L., *See* Bowman, B.R., 2:41538
Efferding, L.E., *See* Cohen, P., 2:41423
Effertz, P.H., Corrosion in condensers and coolers of nuclear power due to cooling water, 2:41813 (EBO-P—673)
Egorov, V.E., Steam cooler plant for steam released for technological purposes, 2:41255
Eichmann, D., New ways for upgrading thermoplastic PE and cross-linked PE-insulated power cables, 2:41296
Eickelpasch, N., *See* Stehle, H., 2:41318
Eiden, H., Power plant tubing--a critical review, 2:41262
Eisenbud, M., *See* Laurer, G.R., 2:42111
Eisenhauer, C.M., *See* Grundl, J.A., 2:41154
Eisenhofer, J.J., *See* Schuetzenduebel, W.G., 2:41365
Elgart, M.F., *See* Rundberg, R., 2:42201
Elger, R., Preparing periodic inspections of A-1 reactor pressure vessel, 2:41372 (INIS-mf—3389, pp 103-113)
Elizen, V.M., Investigation of the kinetics of the oxidation of schungite and of glassy carbon, 2:41876
Elliott, R.O., Splat cooling of some actinide alloys, 2:41760
Ellis, L.C., Age and seasonal differences in the synthesis and metabolism of testosterone by testicular tissue and pineal HIOMT activity of Uinta ground squirrels (Spermophilus armatus), 2:42057
See Buhrley, L.E., 2:42067
See Hargrove, J.L., 2:42068
Ellis, W.P., Auger/loss studies of uranium, uranium oxidation, UO_2, U_3O_8, and UF_4, 2:41781
Elton, R.C., X ray laser research: guidelines and progress at the Naval Research Laboratory, 2:41910
Ely, J., *See* Holditch, S.A., 2:40940
Emberson, W.C., *See* Bridges, J.E., 2:41934
Emmett, M.B., *See* Slater, C.O., 2:41379
Emmons, T.E., Space shuttle engineering and operations support. Orbiter to spacelab electrical power interface. Avionics system engineering, 2:41665 (N—76-28340)
Eng, K.Y., *See* Lee, Y.J., 2:41420
Engel, F.C., *See* Minushkin, B., 2:41421
Engel, R.L., *See* Deonigi, D.E., 2:42272
Engelman, D.M., Protein pair distance determination in the 30 S ribosoma subunit of E. coli, 2:42026 (BNL—50453, pp IV.20-IV.37)
Engelmann, C., *See* Bock, P., 2:41865
Engelmann, P., *See* Beckurts, K.H., 2:41356
Engle, W.W., *See* Williams, M.L., 2:41468
Epstein, G., *See* Heath, G.R., 2:41135
Epstein, H.M., *See* Mallozzi, P.J., 2:42312
Epstein, M., Stability of a submerged frozen crust, 2:41552
Erb, D.E., *See* Beckurts, K.H., 2:41356
Erdmann, V.A., *See* Hoppe, W., 2:42027
Erdosi, N., *See* Szili, G., 2:41305
Erickson, R.E., Reaction kinetics of ozone with sulfur compounds. Final report, 2:41972 (PB—257891)
Eriksson, K., *See* Bergstrom, L.A., 2:41297
Ernest, F.P., *See* Stirn, R.J., 2:41191
Esbensen, T.V., Zero-energy house in Lyngby, 2:41221
Esin, M.P., *See* Akhmedov, R.B., 2:41031
Etchberger, F.R., *See* Sturgeon, R.F., 2:41681, 2:41682
Evans, D.G., *See* Swann, P.D., 2:40847
Evans, D.W., Exchange of manganese, iron, copper, and zinc between dissolved and particulate forms in the Newport River estuary, North Carolina, 2:42003 (RLO—2227-T12-71)
Evans, E.A., Intrinsic material properties of the erythrocyte membrane indicated by mechanical analysis of deformation, 2:42040
Evans, L.G., *See* Trombka, J.I., 2:42149
Everett, L.G., *See* Todd, D.K., 2:42010
Everett, M.E., *See* Norwitz, G., 2:41007
Evreinov, A.N., *See* Stadnik, V.F., 2:40946

F

Fabre, E., Physical characterization of silicon solar cells by determination of spectral response, 2:41193 (N—76-28644)
Fadeev, I.G., *See* Sycheva, A.M., 2:40944
Faiers, M.E., βyieldsα phase transformation in unalloyed plutonium after full and partial β phase formation, 2:41768
See Orme, J.T., 2:41774
Fain, S., *See* Nydick, S.E., 2:41247
Fainer, I.A., *See* Korshunov, A.N., 2:40883
Fairand, B.P., *See* Mallozzi, P.J., 2:42312
Fairchild, J.E., Development and operational validation of a transit bus simulation. Final research report, 2:41684 (PB—254891)
Falk, R.B., Error analysis and propagation of uncertainties for the measurement of inhaled transuranium elements, 2:42098 (BNWL—2088, pp 63-80)
Preliminary evaluations of a high-purity germanium detector system for in vivo measurement of inhaled transuranium elements, 2:42113 (BNWL—2088, pp 229-230)
Fan, L.S., *See* Fan, L.T., 2:40797
Fan, L.T., Model for the extractive coal liquefaction. I. Modeling and simulation of the NenKen coal liquefaction process, 2:40797
Fanjoy, G.R., CANDU fuel: fifteen years of power reactor experience, 2:41368 (IAEA-CN—36/184)
Farberov, I.L., *See* Zil'berbrandt, A.M., 2:40800
Farouq, S.M., Bitumen recovery from oil sands, using solvents in conjunction with steam, 2:41050
Farouq-Ali, S.M., Numerical modeling of the stream method of underground coal gasification, 2:40763 (MERC/SP—76/3, pp 249-255)
Fasching, G.E., *See* Shuck, L.Z., 2:40779
Favrie, E., High voltage polyethylene insulated cables from 63 to 225 kV and their fittings, 2:41291

Faw, R.E., Postaccident heat removal--2. heat transfer from an internally heated liquid to a melting solid, 2:41550
See Baker, L. Jr., 2:41549
Fedorov, A.N., *See* Basov, N.G., 2:42221
Fedoseenko, A.V., *See* Semenovker, I.E., 2:41270
Fedosyuk, A.F., *See* Markov, N.M., 2:41257
Fedotov, A.I., *See* Basov, N.G., 2:42221
Feldman, J.D., *See* Jones, J.M., 2:42056
Feldmann, H.F., Supplemental pipeline gas from coal by the Hydrane process, 2:40792
Fels, M.F., Suburb-to-suburb intercity travel: energy, time and dollar expenditures, 2:41737 (N—76-29064)
Felt, R.E., *See* McCutcheon, E.B., 2:41094
Felton, G.W., *See* Hillenbrand, L.J., 2:40795
Fender, B.E.F., *See* de Novion, C.H., 2:41832
Ferin, J., Lung clearance of particles, 2:42128
Ferrari, G., *See* Campolunghi, F., 2:41410
Ferrigno, D.P., Radwaste treatment study for a once through steam generator cleaning solution, 2:41348
Ferrill, R.S., *See* Sturgeon, R.F., 2:41681, 2:41682
Fichte, W., *See* Effertz, P.H., 2:41813
Filby, R.H., Mode of occurrence of trace elements in petroleum and relationship to oil-spill identification methods, 2:41027
Filina, S.I., *See* Zonn, M.S., 2:40922
Filipchuk, I.G., X-radiographic study of the structure of anthracite and its change on thermal treatment, 2:40822
Filonenko, Yu.Ya., Influence of various factors on the change in the tensile strength of coke, 2:40824
Thermal breakdown of coke in the cooling process, 2:40827
Finfgeld, C.R., Proton sputtering. Final report, 2:42318 (ORO—3557-15)
Fink, Z.J., *See* Borio, R.W., 2:40802
Finney, R.E., Carbon dioxide sources and oilfields in a nine-state area of the southwest United States, 2:40930 (BERC/IC—77/1)
Finston, H.L., *See* Rundberg, R., 2:42201
Firing, J.A., Evaluation of in-reactor measurements of fuel rod deformations, 2:41488 (IAEA-CN—36/495)
Firsov, V.I., *See* Aerov, M.E., 2:40943
Fischer, D.D., Monitoring of emissions from an in situ coal gasification experiment, 2:40762 (MERC/SP—76/3, pp 242-248)
Status of the Linked Vertical Well process in underground coal gasification. 2:40772 (MERC/SP—76/3, pp 354-371)
See Brandenburg, C.F., 2:40748
Fischer, J., *See* Young, J.E., 2:40776
Fishbine, B., *See* Tesche, F.M., 2:41932
Fisher, D.K., Computer-based transportable data-acquisition and control system, 2:41938 (UCRL—78339(Rev.1))
Fisher, G.L., Collaborative efforts in the characterization of stack-collected fly ash, 2:41983 (UCD—472-123, pp 11-14)
Morphology and chemistry of size-classified fly ash collected from the stack of a coal-fired power plant, 2:42120 (UCD—472-123, pp 5-10)
See Chrisp, C.E., 2:42121
See McFarland, A.R., 2:42119
Fisher, R.A., *See* Buder, M.K., 2:40754
Fitch, F.W., Selective suppression of immune responses. Regulation of antibody formation and cell-mediated immunity by antibody, 2:42052
Flanigan, L.J., *See* Carr, J.A., 2:41504
Flannigan, L.J., *See* Novendstern, E.H., 2:41422
Fleming, R.R., Calibration techniques for the in vivo measurement of alpha-emitting actinides, 2:42102 (BNWL—2088, pp 101-106)
Flynn, M.J., Studies in the organization of computer systems. 1976 progress summary. Technical note No. 100, 2:42332 (SU—326-P.39-16)
Fogleman, W.W., *See* Shuman, M.S., 2:42015
Fois, M., *See* Bottiglioni, F., 2:42213
Foley, R.T., *See* Adams, A.A., 2:41663
Fomina, A.S., *See* Pobul, L.Ya., 2:41065
Fontana, A., Cracking of reinforced concrete heated cylindric containers in the presence of thrusting slabs, 2:41482
Fontana, M.H., LMFBR Aerosol Release and Transport Program. Quarterly progress report for October—December 1976, 2:41533 (ORNL/NUREG/TM—90)
Fontane, D.G., *See* Dortch, M.S., 2:41557
Forchhammer, P., *See* Effertz, P.H., 2:41813
Ford, F.A., *See* Meadows, D.L., 2:41584
Ford, J.J., Observations on ecology and national security. Final technical note, 2:41587 (AD-A—026597)
Ford, J.L.C. Jr., *See* Thornton, S.T., 2:42205
Forrester, R.C. III, Two-dimensional studies of coal pyrolysis: preliminary results, 2:40799 (MERC/SP—76/3, pp 402-410)
See Westmoreland, P.R., 2:40798
Forsyth, E.B., Superconducting power transmission: the perils and promise, 2:41299
Fossey, D., *See* Fries, R.J., 2:41149
Fossoul, E., *See* van Dievoet, J., 2:41445
Foster, J.S., CANDU: Canadian experience and expectations with the heavy-water reactor, 2:41367 (IAEA-CN—36/179)
Fowler, C.F., *See* Kok, B., 2:41198
Fox, D., *See* Stanhouse, R.W., 2:41187
Fox, F., *See* Dietrich, I., 2:41884
Fradin, F.Y., Localized vs itinerant 5f electrons: a review of the experimental evidence, 2:41769
Fraenkle, G., New methods for reducing visible emissions of diesel engines, 2:41752
Frank, H.A., Life capability of the silver electrode in alkaline electrochemical cells, 2:41576 (N—76-28648)
See Clarke, R.H., 2:42035
Franklin, N.L., Status and programme for the fast breeder reactor in the UK, 2:41390 (IAEA-CN—36/54)
Franzen, J.E., Some thoughts on coal gasification, 2:40793
Franzidis, J.P., *See* de Kock, J.W., 2:40841
Frato, J., *See* Price, A.R., 2:42055
Frazier, D.H., *See* Bishop, W.P., 2:41127
Frederikse, H.P.R., Electrical conductivity of coal slag, 2:40849
Freedman, R.W., *See* Hartstein, A.M., 2:40836
Freeman, A.J., *See* Koelling, D.D., 2:41772
Freeman, L.E., *See* Labavitch, J.M., 2:42036
Fremiot, C., Irradiation temperature memorization bt retention of krypton-85. Application to the temperature determination for the internal cladding surface of fuel elements in PWR, 2:41327 (CEA-R—4798)
Frenzen, P., Generalized Kolmogorov—von Karman relation and some further implications on the magnitude of the constants, 2:41949 (ANL—75-60(Pt.4), pp 47-50)
Freudenberger, K., *See* Duesing, G., 2:42297
Freundlich, W., *See* Pages, M., 2:41779
Freynik, H.S., Measuring small internal pressures along a tube during steady flow, 2:41941 (UCRL—77305(Rev.1))
Fridman, G.E., Oxyethylation of the phenols and carboxylic acids of the low-temperature tars from the thermal treatment of coals, 2:40810
Friedman, H.W., Design and development of soft x-ray laser. Semi-annual technical report, Mar—Dec 1976, 2:41895 (AD-A—034326)
Friedman, S., Chemical cleaning of coal, 2:40742
Fries, R.J., Recent developments in laser-fusion target coatings, 2:41149 (LA-UR—75-2053)
Fritsch, A.J., Solar energy: one way to citizen control, 2:41657
Fritz, T.A., *See* McKinnon, J.A., 2:41930
Froes, F.H., *See* Berryman, R.G., 2:41756
Frolova, L.N., *See* Kondrat'ev, A.A., 2:40942
Frost, C.M., Hydrogenating shale oil at low space velocity, 2:41055
Methods for refining crude shale oil produced by in situ retorting, 2:41056
Fry, R.J.M., *See* Ley, R.D., 2:42083
Fugas, M., *See* Gentilizza, M., 2:41984
Fujita, J., Experiments on JIPP T-II, a hybrid system of stellarator and Tokamak, 2:42271 (AED-Conf—76-506-007)
Fujita, N., Effects of modeling variations on RELAP4. predictions of Standard Problem Five, 2:41544
Fujiwara, M., *See* Fujita, J., 2:42271
See Hamada, Y., 2:42241
Fukuda, K., *See* Gomay, Y., 2:42317
Fukushima, M., *See* Tanaka, S., 2:42270
Fukuta, N., *See* Sturrock, P.A., 2:42165
Fukuyama, T., *See* Miyazu, T., 2:40734
Fullam, H.T., Quarterly report on the strontium heat source development program and the beneficial isotopes utilization program, Division of Nuclear Research and Application for October—December 1976, 2:41155 (BNWL—1845-31)
Funk, C.W., Caustic stress corrosion cracking, 2:41388 (HEDL-SA—1122)
Furukawa, K., *See* Katsuta, H., 2:42323
Furuta, T., *See* Sanada, Y., 2:40736

G

Gabaglio, M., *See* Arcelli, G., 2:41331
Gaddy, E.M., Results from the IMP-J violet solar cell experiment and violet cell balloon flights, 2:41188 (N—76-30657)
Gagarin, S.G., Mathematical description of the hydrocracking of distillates from the liquid-phase hydrogenation of coal, 2:40744
Gal, J., Hyperfine interactions in Np Pdsub(3-x)Rhsub(x), 2:41770
Itinerant magnetism in $NpFe_2Si_2$ and $NpCo_2Si_2$, 2:41799
Galaktionov, I.V., *See* Baturov, B.B., 2:41449
Galan, M., *See* Norwitz, G., 2:41007, 2:41008
Gale, J., *See* Tomlinson, M., 2:41116
Galkin, B.Ya., Discharge into the atmosphere of volatile fission products from nuclear power stations and fuel reprocessing plants and the perspectives of their retention, 2:41132 (IAEA-CN—36/317)
Gallagher, W.J., *See* Mallozzi, P.J., 2:42312
Gallegos, O.A., Preliminary engineering and economic evaluation of underspoil haulage in area strip coal

mines. Part I. Summary report, 27 Jun—10 Oct 1975, 2:40874 (PB—254575)
Galloway, L.M., *See* Wang, S.T., 2:40878
Galluzzo, N.G., Design considerations for systems subject to sodium/water reactions, 2:41413
Galperin, Y.I., Polar aurora in the magnetosphere, 2:42193 (N—76-27751)
Galushko, V.F., *See* Saprykin, G.S., 2:41272
Galvin, T.M., *See* Wrona, B.J., 2:41556
Gandman, Z.I., *See* Aerov, M.E., 2:40943
GangaRao, H.V.S., *See* Advani, S.H., 2:40813
Gangl, M., *See* Jungmann, A., 2:41339
Gangloff, W.C., Common mode failure analysis, 2:41539
Ganiev, Yu.A., *See* Rastorguev, Yu.L., 2:40965
Gant, R.G., Braze ring qualification program, 2:41506 (UNI—187(Rev.1))
Gardner, L., Production of hydrocarbon-type synthetic fuel from wood, 2:41171 (AD-A—034359)
Gardner, L.J., The correlation of the 10 to 30 MeV proton flux from the NOAA satellites and the Thule 30 MHz riometer. Technical memo, 2:42186 (PB—256 102)
Garland, J.G., Metallurgical factors controlling weld metal toughness in the seam welding of line pipe, 2:41758 (PB—256057)
Garon, A.M., Economic evaluation of underground coal gasification, 2:40755 (MERC/SP—76/3, pp 155-168)
Gartler, D.J., Lifting cylinder combustion engine with preheated suction pipe, 2:41714
Gaspar, M.J., *See* Hargrove, J.L., 2:42068
Gasper, W., Survey of high-output transformers and a look at possible future developments, 2:41285
Gates, J.M., Economics of power plant siting in southeastern New England. Final report, 2:41283 (PB—254743)
Gatesoupe, J.P., *See* de Franco, M., 2:41840
Gatti, S., *See* Arcelli, G., 2:41331
Gazdiev, M.A., *See* Bogatov, G.F., 2:40999
Gear, C.W., Future developments in stiff integration techniques: stability of methods that do not use an exact Jacobian, 2:42326 (COO—2383-0035)
Gedeonov, L.I., *See* Blinov, V.A., 2:41140
See Galkin, B.Ya., 2:41132
Geisler, K.W., Graphs for determination of exhaust gases and radiation heat exchanger size in steam generators, 2:41266
Gellis, Yu.K., *See* Proskulryakov, V.A., 2:41067
Gendel'man, B.G., *See* Sycheva, A.M., 2:40944
Gentilizza, M., Value of stabilizers in the determination of sulphur dioxide in the air, 2:41984
Gera, F., Radioactive waste disposal in geological formations, 2:41138 (IAEA-CN—36/313)
Gerasimov, V.F., *See* Shishkin, G.G., 2:42249
Gerevini, T., *See* Arcelli, G., 2:41331
Gerike, B.I., *See* Korshunov, A.N., 2:40885
Gevorkov, A.K., *See* Demirkhanov, R.A., 2:42256
Gibson, E.F., *See* Chang, H.H., 2:42202
Gibson, E.G., Observations of limb flares with a soft x-ray telescope, 2:42163 (N—76-27149)
Giedt, R.R., *See* Chodzko, R.A., 2:41891
Giessen, B.C., *See* Elliott, R.O., 2:41760
Gilbert, L.J., *See* Hwang, H.H., 2:41244
Gilbody, H.B., *See* Barnett, C.F., 2:42231
Gill, R.D., *See* Atkinson, D.W., 2:42211
Gillen, W.J., *See* Cicchetti, C.J., 2:41274
Gilliam, D.M., *See* Grundl, J.A., 2:41154
Gillis, J.M., *See* Worcester, D.L., 2:42024
Gintz, J.R., Closed cycle, high-temperature central receiver concept for solar electric power, 2:41202 (PB—254399)
Giraud, M.B., *See* Redon, A., 2:41119
Gitlitz, P.H., Aminoaciduria and proteinuria in rats after a single intraperitoneal injection of Ni(II), 2:42126
Glados, S., *See* Okrajni, S., 2:40934
Glebov, I.A., Cascade start-up of generator-motors at pumped storage hydroelectric plants, 2:41560
Gleim, P.S., *See* Rea, S.N., 2:41184
Gloaguen, A., *See* Brandt, R.C., 2:41334
Glushkov, E.S., *See* Aleksandrov, A.P., 2:41438
Goans, R.E., Calibration techniques and error analysis for phoswich counting of actinide nuclides at Oak Ridge National Laboratory, 2:42096 (BNWL—2088, pp 19-37)
Gobetz, F.W., Cost/benefit trade-offs for reducing the energy consumption of commercial air transportation (RECAT). Final report, 2:41605 (N—76-28203)
Cost/benefit trade-offs for reducing the energy consumption of commercial air transportation (RECAT). Summary report, 2:41606 (N—76-28204)
Godfrey, C.S., *See* Van Thiel, M., 2:41940
Goepner, W., *See* Plesser, N., 2:41036
Goergen, H., Site selection of lignite-fed power plants based on fuel supplies, 2:41284
Goetz, G.J., *See* Borio, R.W., 2:40802
Goetze, W., Road supports at the International Mining Exposition 1976, 2:40894
Gol'dberg, Yu.A., *See* Semenovker, I.E., 2:41270
Gol'tsev, V.P., *See* Krasin, A.K., 2:41397
Golchert, N.W., Environmental monitoring at Argonne National Laboratory. Annual report for 1976, 2:41961 (ANL—77-13)
Gold, R.L., A comparative case study of the impact of coal development on the way of life of people in the coal areas of eastern Montana and northeastern Wyoming. Final report, 2:40856 (PB—254924)
Goldberg, G., Testing of coatings for the nuclear industry, 2:41466 (CONF-770301—12)
Goldberg, S.M., Assessment methodology of environmental risks associated with radioactive waste management, 2:41113 (IAEA-CN—36/28)
Goldblatt, P.J., *See* Gitlitz, P.H., 2:42126
Goldman, L., Third conference on the laser, 2:41909
Goldman, M., Annual report, fiscal year 1976, 2:42118 (UCD—472-123)
See Chrisp, C.E., 2:42079, 2:42089
Goldsmith, W.A., *See* Kennedy, R.H., 2:41125
Goldwasser, E., *See* van Zant, G.E., 2:42070
Golemon, H.A., University of Houston student center, 2:41615 (NSF-RA—760006, pp 131-134)
Golomb, H.M., *See* Hamburg, A., 2:42041
Golovanov, N.G., Extraction resins of brown coals, 2:40805
Golovanov, V.I., *See* Shramko, V.M., 2:40884
Golovina, N.B., *See* Tesner, P.A., 2:41168
Golovnin, I.S., *See* Zaimovskii, A.S., 2:41444
Gomay, Y., Estimate of low-Z materials for the first wall of JT-60, 2:42317 (JAERI-M—6432)
Gomberg, H.J., Laser fusion at KMSI/KMSF, 2:42311
Gomozov, L.I., Physical and mechanical properties of some uranium-containing carbides, 2:41837
Gonzaga, M., Recovery of uranium as a by-product of phosphorites from Brazilian northeast area, 2:41076 (IEA—416)
Good, W.M., *See* Goans, R.E., 2:42096
Goodarzi, F., Optical properties of carbonized preoxidized vitrinites, 2:40837
Optical roperties of carbonized vitrinites, 2:40840
Oxidized vitrinites: their aromaticity, optical properties, and possible detection, 2:40839
Gooding, C.H., Comparative U.S./USSR tests of a hot-side electrostatic precipitator. Final report, Jan 1975—Sep 1976, 2:41279 (PB—261918)
Gorchakov, Y.V., Measurement of hard cosmic rays in September 1973 by Mars-4, Mars-5 and Mars-7, 2:42151 (N—76-29148)
Gordon, C.W., *See* Harms, A.A., 2:42289
Gordon, H., *See* Norwitz, G., 2:41006
Gore, K.L., Evaluation of Millstone Nuclear Power Plant, Environmental Impact prediction, based on monitoring programs, 2:41313 (BNWL—2152)
Evaluation of nuclear power plant environmental impact prediction, based on monitoring programs. Summary and recommendations, 2:41492 (BNWL—2153)
Gorenkov, A.F., *See* Gulin, E.I., 2:40961
Gorlach, N.G., *See* Bychev, M.I., 2:40826
Gorodetskii, A.E., *See* Tesner, P.A., 2:41168
Goverdovskii, E.E., *See* Plotkin, E.R., 2:41258
Graham, J.P., Solving the coking coal problem, 2:40735
Gray, D.A., *See* Mitchell, N.T., 2:41136
Gray, D.D., *See* Adams, S.M., 2:41494
Gray, D.E., Study of unconventional aircraft engines designed for low energy consumption. Final report, 2:41742 (N—76-29233)
Gray, G.R., Conversion of Athabasca bitumen, 2:41052
Gray, K.E., *See* Thompson, T.W., 2:40768
Graziani, G., *See* Charrault, J.C., 2:41304
Grebennik, V.N., *See* Aleksandrov, A.P., 2:41438
Greenberg, B., *See* Lacks, S., 2:42048
Greenlee, T.L., Eigenvalue sensitivity study of a high temperature gas cooled reactor system, 2:41364
Gregg, D.W., *See* Gunn, R.D., 2:40766
Greif, K., *See* Svoboda, V., 2:41373
Gridin, I.D., Ways of reducing heat losses in the regeneration of alkali absorbents, 2:41173
Grier, W.F., Demonstration of coal mine haul road sediment control techniques. Final report, 2:40879 (PB—258304)
Griffith, P., *See* Smith, R.A., 2:41545
Grigor'ev, B.A., *See* Bogatov, G.F., 2:40999
See Rastorguev, Yu.L., 2:40965
Grimes, S.M., *See* Hansen, L.F., 2:42290
Grishaev, V.I., Excitation of electromagnetic waves in the range of plasma resonance in inhomogeneous plasma by nonlinear langmuir oscillations, 2:42260
Grisham, L.R., Free expansion experiment on ATC, 2:42218 (PPPL—1330)
Gritzner, M.L., *See* Simmons, G.L., 2:41362
Groenendaal, W., Shell flue gas desulfurization process: demonstration on oil- and coal-fired boilers, 2:40851

Groenier, W.S., *See* Holland, W.D., 2:41099
Gromozov, L.I., Some rules in the strengthening of uranium alloys, 2:41787
Grooms, D.W., Time series forecasting and prediction (a bibliography with abstracts). Report for 1964—Jan 1977, 2:41666 (NTIS/PS—77/0042)
Grose, L.T., Geothermal energy in the pacific region. Appendix A: exploration for a geothermal system in the Lualualei Valley, Oahu, Hawaii. Appendix B: exploration on Adak Island, Alaska, 2:41234 (AD-B—006305)
Gross, K., Steam piston engine, 2:41727
Grotta, H.M., *See* Hillenbrand, L.J., 2:40795
Grube, D.D., *See* Ley, R.D., 2:42083
Gruber, R., *See* Berger, D., 2:42239
Grubitzsch, W., Pressure pulsations and spiral vibration when ventilating storage pumps, 2:41562
See Kreher, K., 2:41561
Grundl, J.A., Californium-252 fission spectrum irradiation facility for neutron reaction rate measurements, 2:41154
Gryazev, V.M., *See* Kazachkovskii, O.D., 2:41398
See Zaimovskii, A.S., 2:41444
Grzes, M., Design schemes of small diameter drillings in coal deposits, 2:40890
Guerrero Morillo, H.L., Fabrication of nuclear fuel elements in Mexico, 2:41087 (IAEA-CN—36/540)
Guidry, M.W., *See* Sturm, R.J., 2:42198
Gulati, I.B., *See* Agrawal, B.B., 2:41017
Guldberg, P., *See* Benesh, F.H., 2:41970
Gulin, E.I., Classification of petroleum-derived fuels, 2:40961
Gulyaeva, N.D., Laws of the distribution of normal and isoprenoid alkanes in coals of different ranks, 2:40832
Gunji, M., *See* Sakai, T., 2:41796
Gunn, R.D., Theoretical analysis of Soviet in situ coal gasification field tests, 2:40766 (MERC/SP—76/3, pp 272-284)
Gupta, P., Studies of temperature sensitive mutants of bacteriophage Qβ, defective in both replication and translation, 2:42045
Gurdzinska, E., *See* Bukowski, A., 2:40948
Gurnett, D.A., *See* Kintner, P.M., 2:42190
Gustafson, D.E., *See* Thornton, S.T., 2:42205
Gustova, L.I., *See* Blinov, V.A., 2:41140
Gutberlet, L.C., *See* Brooks, J.A., 2:40796
Gutbrod, H.H., Central collisions of relativistic heavy ions, 2:42207
Guter, G.A., Assessment of long-term environmental impacts by computer modeling, 2:42016
Gutmann, R.J., *See* Borrego, J.M., 2:41933
Gutzeit, J., Evaluating refinery process side corrosion inhibitors, 2:40952
Gyimesi, Z., *See* Szili, G., 2:41305

H

Haacke, G., Cadmium stannate selective optical films for solar energy applications. Final report, 1 Jul 1973—31 Aug 1976, 2:41228 (PB—261850)
Haarman, R., *See* Burkhardt, L.C., 2:42299
Haas, J.C., *See* Borio, R.W., 2:40802
Haas, R.A., *See* Ahlstrom, H.G., 2:42308
Habberjam, G.M., Comparison of sounding results and their interpretation in the absence of borehole control, 2:42143
Habenschuss, A., *See* Rard, J.A., 2:41877
See Spedding, F.H., 2:41873
Haber, I., *See* Basu, B., 2:42234
Hackett, C.E., Laser velocimetry measurements in the cavity of HF chemical laser (cavity injector type CL-II), 2:41907 (SAND—76-9314)
Hadari, Z., *See* Gal, J., 2:41770, 2:41799
Haessler, M., Electronic structure of mixed uranium-thorium monochalcogenides, 2:41864
Haff, P.K., *See* Switkowski, Z.E., 2:42150
Hagan, M.P., *See* Basu, S., 2:42179
Hage, W., *See* Cecille, L., 2:41133
Hahn, L., Innovations and trends in face supports at the international mining exposition 1976, 2:40893
Hahn, O.J., Underground gasification at the University of Kentucky, 2:40778 (MERC/SP—76/3, pp 430-433)
Hahn, W., *See* Schilg, G., 2:41411
Haines, H.R., Some constitutional studies on uranium-carbon- and plutonium-carbon-rhenium and technetium systems, 2:41827
See McElroy, D.L., 2:41841
Hairion, J.P., *See* Maman, A., 2:41486
Hake, V., *See* Barbur, I., 2:41301
Halcrow, B.W., F_2 peak electron densities in the main trough region of the ionosphere, 2:42180 (N—76-24798)
Hall, B.A., Materials problems associated with the development of geothermal energy resources, 2:41240 (PB—254990)
Hall, D.E., *See* Mason, R.Z., 2:40758
Hall, G., Evaluation of a carbon-rod atomizer for routine determination of trace metals by atomic-absorption spectroscopy. Applications to analysis of lubricating oil and crude oil, 2:41016
See Chakrabarti, C.L., 2:41012
Hall, R.O.A., *See* McElroy, D.L., 2:41841
Halle, H., Fluidelastic tube vibration in a heat exchanger designed for sodium-to-air operation, 2:41505
Hallett, J.L., Means for detecting and neutralizing leaks in electrochemical cells, 2:41570
Hamada, Y., Study of helical plasma equilibria, 2:42241
See Fujita, J., 2:42271
Hamberger, S.M., *See* Atkinson, D.W., 2:42211
Hamburg, A., Human cord blood lymphocytes. Ultrastructural and immunologic surface marker characteristics: a comparison with B- and T-cell lymphomas, 2:42041
Hamburg, F.C., Feasibility of a single tall stack in power plant construction. Final report, 2:41277 (PB—255952)
Hamburger, R., Strategies for legislative change, 2:41633 (NSF-RA—760006, pp 243-246)
Hamilton, C.J., *See* Marshall, A.C., 2:41353
Hammer, J.H., *See* Merz, M.D., 2:41789
Hamstra, J., Review of Dutch geologic waste disposal programme, 2:41137 (IAEA-CN—36/289)
Hankinson, O., Mutants of the Chinese hamster ovary cell line requiring analine and glutamate, 2:42047
Hann, R.W. Jr., *See* Jensen, P.A., 2:40991
Hannerz, K., Reactor waste heat utilization and district heating reactors. Nuclear district heating in Sweden - Regional reject heat utilization schemes and small heat-only reactors, 2:41448 (IAEA-CN—36/275)
Hans, R., New type sodium flow meter for fuel elements in nuclear power stations, 2:41415
Sodium contamination measurement with plugging meter and hydrogen leak detection system, 2:41414
Hansen, J.P., Electrical engineering characteristics of MHD generators operating by emulsion, 2:41661
Hansen, K.F., *See* Olmos, J., 2:41455
Hansen, L.F., Calculations of the neutron emission spectra from materials bombarded with 14-mev neutrons, 2:42290
See Dietrich, F.S., 2:42200
Hanson, J.E., *See* Roake, W.E., 2:41512
Hardenberg, H.O., *See* Fraenkle, G., 2:41752
Hardt, H.H., *See* Kok, B., 2:41198
Hardy, E.P. Jr., Health and Safety Laboratory environmental quarterly, December 1, 1976—March 1, 1977, 2:42085 (HASL—318)
Hargrove, J.L., Indomethacin induces rat uterine contractions in vitro and alters reactivity to calcium and acetylcholine, 2:42068
Harms, A.A., Fissile fuel breeding potential with paired fusion-fission reactors, 2:42289
Harnden, D.S., NSF-RANN trace contaminants abstracts, 2:42117 (ORNL/EIS—107)
Harpole, G.M., Laminar natural convection about downward facing heated blunt bodies to liquid metals, 2:41546
Harries, W.L., X-ray emission from high temperature plasmas. Annual report, 1 Jul 1975—30 Jun 1976, 2:42230 (N—76-28015)
Harrington, J.A., Chemical laser window measurements. Final report 7 May 1975—6 May 1976, 2:41893 (AD-A—028402)
Harris, J.A., *See* Swann, P.D., 2:40847
Harrison, E.A., Biodeterioration of oil spills (a bibliography with abstracts). Report for 1964—Jan 1977, 2:42008 (NTIS/PS—77/0046)
Harrison, J.W., Technology and economics of flue gas NO/sub x/ oxidation by ozone. Final report, Jul—Oct 1976, 2:41975 (PB—261917)
Hartmann, G., Overall probability of detection in connection with the optimization of safeguards effort, 2:41146
Hartstein, A.M., Novel wet-digestion procedure for trace-metal analysis of coal by atomic absorption, 2:40836
Hasegawa, A., Concept of a fusion burner, 2:42281
Kinetic theory of MHD instabilities in a nonuniform plasma, 2:42253
Hassan, H.A., Electron Boltzmann equation in a plasma generated by fission fragments, 2:42195 (N—76-29018)
Hathaway, S.A., Technical evaluation study: solid waste as a fuel at Ft. Bragg, N. C. Final report, 2:41174 (AD-A—034416)
Hatler, L.E., *See* Randolph, A.D., 2:41942
Hatori, T., *See* Hasegawa, A., 2:42281
Hatterer, A., *See* Bock, P., 2:41865
Haut, R.C., Prandtl-Meyer flow tables for parahydrogen at total temperatures from 30°K to 290°K and for nitrogen at total temperatures from 100°K to 300°K at total pressures from 1 atm to 10 atm, 2:41164 (N—76-30497)
Hayatdavoudi, A., *See* Warren, T.M., 2:40814
Haynes, R.R., *See* Shoemaker, H.D., 2:40815
Hays, R.M., *See* Scott, R.L., 2:42011
Haywood, F.F., *See* Kennedy, R.H., 2:41125
Heath, D.F., Measures of the solar spectral irradiance between 1200 and 3000 a, 2:42169 (N—76-31126)
Heath, G.R., Seabed disposal program: geochemical and sedimentological

studies of North Pacific sediments. Progress report, January 1, 1976—December 31, 1976, 2:41135 (COO—2689-6)
Heath, L.J., *See* Finney, R.E., 2:40930
Heaton, H.T. II, *See* Grundl, J.A., 2:41154
Hechmer, J.L., *See* Wu, J.N.C., 2:41474
Hecker, S.S., Effect of strain rate on the tensile properties of α- and delta-stabilized plutonium, 2:41788
See Rohr, D.L., 2:41156
Heckman, B., *See* Postle, W., 2:42338
Heeren, H., Natural-draft cooling tower of the so-called dry type, 2:41252
Heid, K.R., Role of chest counting in personnel dosimetry, 2:42095 (BNWL—2088, pp 11-17)
Heilig, K., Isotopic shift between the even numbered Sr isotopes 84, 86, 88 and 90 and the jump in nuclear volume effect in the case of neutron count 50, 2:42203 (N—76-30045)
Heimdahl, R.B., *See* Holland, W.D., 2:41099
Hejna, J., *See* Mantlik, F., 2:41458
Hemp, W.S., *See* To, J.K.W., 2:41253
Henderson, T.M., Fusion fuel pellet and method for its fabrication, 2:41153
Thermonuclear fuel and its preparation process, 2:41151
Hendrickx, A.G., *See* Andersen, A.C., 2:42080
Henkel, H.J., *See* Kostka, H., 2:41754
Hennig, Th., Comparative measurements on large steam turbines, 2:41265
Henry, A.F., *See* Kalambokas, P.C., 2:41340
Henry, J.F., Groundwater contamination from in-situ coal gasification: laboratory studies, 2:40854 (MERC/SP—76/3, pp 105-118)
Herakovich, C.T., *See* Renieri, G.D., 2:41861
Hermsen, R.W., Ignition of coalbeds for underground gasification, 2:40781 (MERC/SP—76/3, pp 471-476)
Hersey, D.F., Information on international research and development activities in the field of energy, 2:41582 (PB—254315)
Hess, G.D., PBL scaling using surface flux information, 2:41953 (ANL—75-60(Pt.4), pp 10-15)
PBL structure: the Sangamon Experiment of 1975, 2:41951 (ANL—75-60(Pt.4), pp 1-4)
Preliminary look at the diurnal behavior of the PBL, 2:41952 (ANL—75-60(Pt.4), pp 5-9)
See Wesely, M.L., 2:42000
Hesser, J.E., *See* Warren, W.H. Jr, 2:42153
Hetman, J.S., Coulometric micro-determination of sulphur and chloride in mineral oils, deposits, and solvent-extraction residues, 2:41019
Oxygen-bomb coulometric determination of vanadium in oils, 2:41015
Hettinger, H., *See* Cecille, L., 2:41133
Hewitt, R.G.L., *See* Bartlett, D.V., 2:42228
Hibar, J.R., Regional air pollution study: quality assurance audits. Final report, 2:41967 (PB—255313)
Hickey, B., *See* Smith, J.D., 2:42146
Hicks, B.B., Eddy-flux measurements at the Dresden cooling pond, 2:42014 (ANL—75-60(Pt.4), pp 58-63)
Examination of some bulk formulae used for assessing the performance of industrial cooling ponds, 2:42001 (ANL—75-60(Pt.4), pp 69-75)
Instrumental requirements for the measurement of pollutant fluxes, 2:41960 (ANL—75-60(Pt.4), pp 51-57)
Preliminary tests of a model of cooling-pond thermal performance, 2:42002 (ANL—75-60(Pt.4), pp 76-80)
See Hess, G.D., 2:41951, 2:41952, 2:41953
See Wesely, M.L., 2:42000
Higgins, G.H., New concept for in situ coal gasification, 2:40791
Higgins, G.T., *See* Wrona, B.J., 2:41556
Hilbert, G.S., Function and evaluation of air-conditioned luminaires--2, 2:41671
Hill, B.J., Fluidised combustion, 2:41176
Hill, J., *See* Franklin, N.L, 2:41390
Hill, R.W., *See* Stephens, D.R., 2:40749
Hillenbrand, L.J., Catalyst development program for hydrodesulfurization and liquefaction of coal to produce clean boiler fuels. Quarterly report, September—November 1976, 2:40795 (FE—2321-8)
Hinoki, M., *See* Aoki, S., 2:41526
Hinton, B.M., *See* Kroenke, W.C., 2:41477
Hirose, A., *See* Lonngren, K.E., 2:42243
Hirsch, D.E., Compound-type separation and characterization studies for a 370° to 535°C distillate of Wilmington, Calif., crude oil, 2:41023
See Dooley, J.E., 2:41021, 2:41022
Hirschkron, R., *See* Neitzel, R.E., 2:41743
Hnyilicza, E., Long-run model for energy policy analysis, 2:41635
Hodgson, R.T., *See* Sorokin, P.P., 2:41912
Hoekstra, G.B., *See* Mosby, J.F., 2:40958
Hoekstra, H.R., *See* Veal, B.W., 2:41849
Hofbauer, P., Rotary piston combustion engine, 2:41724
Hoffman, C.A., Tensile behavior of unnotched and notched tungsten—copper laminar composites, 2:41782 (N—76-26287)
Hofmann, R., 'STEALTH' a Lagrange explicit finite-difference code for solids structural, and thermohydraulic analysis. Technical report, 2:41456 (PB—255405)
Hogan, J.T., *See* Grisham, L.R., 2:42218
Holbrook, C.H., Clinical case load for radionuclide-treated beagles, calendar year 1975, 2:42088 (UCD—472-123, pp 90-93)
Holdeman, J.T. Jr., PREPR2: a program to aid in the preparation of input data for the farout hydraulic transport code, 2:41495 (ORNL/CSD/TM—19)
Holden, S.C., Slicing of silicon into sheet material. Silicon sheet growth development for the large area silicon sheet task of the low cost silicon solar array project. Third quarterly report, September 20, 1976—December 19, 1976, 2:41182 (ERDA/JPL/954374—76/4)
Holder, J., *See* Moreau, C., 2:41084
Holditch, S.A., Successful stimulation of deep wells using high proppant concentrations, 2:40940
Holland, W.D., Nuclear fuel dissolution and rinsing studies using a continuous rotary dissolver, 2:41099 (ORNL/TM—5566)
Hollenstein, C., *See* Tran, M.Q., 2:42264, 2:42265
Holman, J.P., Fluidized vortex incineration of waste. Final report May 70—Aug 74, 2:41175 (PB—258071)
Holmes, H.L., Effect of intramolecular hydrogen bonding on partition coefficients. Technical note, 2:41871 (AD-A—030683)
Holmes, J.A.G., *See* Bishop, J.F.W., 2:41391
Holmes, J.J., Electromagnetic wave propagation within a subsurface coal seam for in-situ gasification application, 2:40761 (MERC/SP—76/3, pp 238-241)
Holmes, J.T., Sodium purification by cold trapping at the Experimental Breeder Reactor II, 2:41426
Holoszyc, M., *See* Billheimer, J.W., 2:41686, 2:41701, 2:41702
Holt, S.S., The 35-d x-ray profile of Her X-1, 2:42160 (N—76-31109)
See Becker, R.H., 2:42157
See Kaluzienski, L.J., 2:42158
Holtz, W.G., Field compaction tests. Research and development program on the disposal of retorted oil shale-Paraho Oil Shale Project. Open file report, 2:41068 (PB—254728)
Holzen, H.H., *See* Dougherty, M.T., 2:40857
Holzer, R., Nuclear fuel in water reactors: manufacturing technology operational experience and development activities in the Federal Republic of Germany, 2:41083 (IAEA-CN—36/103)
Holzrichter, J.F., *See* Ahlstrom, H.G., 2:42308
Homan, F.J., *See* Lotts, A.L., 2:41359
Homann, C., *See* Huebner, H., 2:41917
Honarkhah, L., Determination of trace amounts of total sulfur in light petroleum distillates, 2:41018
Honcu, E., Reproducibility problems of in-service ultrasonic testing results, 2:41470 (INIS-mf—3389, pp 123-148)
Honda, H., *See* Sanada, Y., 2:40736
Hood, P., Mineral exploration trends and developments in 1976, 2:41075
Hooie, D.T., *See* Schorr, J.R., 2:41977
Hookway, B.R., *See* Mitchell, N.T., 2:41136
Hooper, E.B. Jr., Beam-plasma instability in ion beam systems used in neutral beam generation, 2:42279 (UCID—17404)
Hopkins, B.D., *See* Bangerter, C.D., 2:41658
Hopkins, H.T., *See* Mills, T.R., 2:41999
Hopkins, R.L., *See* Dooley, J.E., 2:41021
Hoppe, W., Neutron scattering measurements with the label triangulation method on the 50 S subunit of E. coli ribosomes, 2:42027 (BNL—50453, pp IV.38-IV.48)
Hori, M., *See* Kikuchi, Y., 2:41527
Horiuchi, M., *See* Yagi, E., 2:41097
Horsbrugh, P., Urban geotecture: the invisible features of the civic profile, 2:41589 (NSF-RA—760006, pp 151-164)
Hosler, W.R., *See* Frederikse, H.P.R., 2:40849
Houston, J.R., *See* Palmer, H.E., 2:42104
Houtman, D.S., *See* Andrews, S.C., 2:42009
Hovel, H.J., The optimization of Ga(1-x)Al(x)As-GaAs solar cells for air mass zero operation and a study of Ga(1-x)Al(x)As-GaAs solar cells at high temperatures, Phase 1. Final report, 2:41186 (N—76-28645)
Howard, J.B., *See* Bush, T.W., 2:40743
Howerton, R.J., *See* Hansen, L.F., 2:42290
Hsu, J.C., *See* Dunn, W.L., 2:41535
Hsu, M.B., *See* Pai, D.H., 2:41363
Huang, C.J., Cargo transportation by airships: a systems study. Final report, 2:41735 (N—76-27164)
Huang, S., *See* Cozzarelli, F.A., 2:41818
Huang, S.S., Orbital changes of the gaseous ring around B/sub e/ stars, 2:42156 (N—76-30126)
Huber, B., *See* Cecille, L., 2:41133
Huebel, D., *See* Kessler, G., 2:41529
Huebner, H., Characteristics of CO_2 TE-amplifiers with different uv preionization at superatmospheric pressure with doping additives, 2:41917
Hugenholtz, C.A.J., CO_2-laser interferometer with direct read-out of phase-shift, 2:42227 (Rijnhuizen—76-100)
Hui, B., *See* Basu, B., 2:42234
Hulinsky, V., *See* Neumann, L., 2:41134
Hulmes, D.J.S., *See* Miller, A., 2:42023
Hultgren, A., *See* Larsson, A., 2:41128

Humphrey, A.E., Practical considerations in designing an UCG field test, 2:40770 (MERC/SP—76/3, pp 339-343)
Hunt, W.F. Jr, Guideline for public reporting of daily air quality: Pollutant Standards Index (PSI). Final report, 2:41992 (PB—257892)
Hupp, H., *See* Goergen, H., 2:41284
Hurn, R.W., Diesel emissions measurement and control, 2:41748
Hurter, T., Transformers manufactured in brazil, 2:41286
Huss, M.F., Procedure for optimizing rapid transit car design. Project report, 2:41729 (PB—255048)
Hust, J.G., *See* Clark, A.F., 2:41885
See Reed, R.P., 2:41784
Huston, J.C., Surface directional permeability analyzer, 2:40784 (MERC/SP—76/3, pp 507-518)
Hutchins, J.C., *See* Robbins, J.D., 2:41998
Hutchinson, H.L., *See* Fischer, D.D., 2:40772
See Humphrey, A.E., 2:40770
Huxford, R.C., *See* Rowe, W.G.E., 2:41689
Hwang, H.H., Transient analysis of unbalanced short circuits of the ERDA—NASA 100-kW wind turbine alternator, 2:41244 (N—76-30650)
Hwang, K.C., *See* Rousseau, J., 2:41210

I

Ibel, K., *See* Hoppe, W., 2:42027
See Worcester, D.L., 2:42024
Ide, T., Evaluation of neutron streaming through injection ports in a tokamak-type fusion reactor, 2:42286 (JAERI-M—6475)
Ignatev, V.A., *See* Gorchakov, Y.V., 2:42151
Iida, H., *See* Ide, T., 2:42286
Iida, S., *See* Sakai, T., 2:41796
Ikeda, T., *See* Sakai, T., 2:41796
Ikhlov, E.M., *See* Bakumenko, O.D., 2:41396
Ikuta, K., Condition for absolute confinement of alpha particles in axisymmetric tori, 2:42215 (N—76-25021)
See Ohasa, K., 2:42295
Ikuta, T., *See* Hasegawa, A., 2:42281
Il'enko, B.K., *See* Stadnik, V.F., 2:40946
Imakuma, K., Development of a routine method for the determination of mean crystallite dimensions in nuclear materials by X-ray diffraction line broadening. An application example using U_3O_8 microspheres, 2:41088 (IEA—405)
Imuta, K., *See* Ouchi, K., 2:40842
Inaba, H., Lambda-type heat capacity anomalies in U_3O_8, 2:41852
Inglis, G.H., *See* Pickman, D.O., 2:41366
Inkson, J.C., Theory of solid surfaces. Final scientific report 1 Oct 1972—30 Sep 1975, 2:42209 (AD-A—031022)
Inoue, S., Anomalous diffusion of alpha particles in the non-linear trapped-ion regime, 2:42251
Inoue, T., Enhancement of U_2C_3 deposition in electron bombarded UC+UC_2, 2:41856
Iokhel'son, Z.M., Present state and future prospects of development of coal pit lighting, 2:40891
Iozenas, V.A., *See* Gorchakov, Y.V., 2:42151
Irani, A.A., *See* Fujita, N., 2:41544
Irie, H., Ammonia leakage test, 2:41041
Irresberger, H., *See* Hahn, L., 2:40893
Irvine, H.S., *See* Tomlinson, M., 2:41116
Ishchenko, V.N., Superradiative rare gas halide lasers excited by electric discharge, 2:41915
Ishida, T., *See* Sakai, T., 2:41796
Ishigai, T., *See* Katsuta, H., 2:42323
Iskhakov, Kh.A., *See* Mizin, V.G., 2:40828
Itaki, T., *See* Muto, T., 2:41489
Ito, A., *See* Miyanaga, I., 2:41115
Itoh, K., *See* Hasegawa, A., 2:42281
See Inoue, S., 2:42251
Itoh, S., *See* Fujita, J., 2:42271
Iura, T., Research plan for achieving reduced automotive energy consumption, 2:41711 (PB—255929)
Ivanov, L.A., Cyclic temperature fluctuations in marine diesel combustion chamber walls, 2:41721
Ivanov, O.S., *See* Gomozov, L.I., 2:41837
See Gromozov, L.I., 2:41787
See Sophronova, R.M., 2:41776
See Terechov, G.I., 2:41805
Ivanov, V.V., *See* Tarasov, B.G., 2:40865
Ivanova, I.M., *See* Blinov, V.A., 2:41140
Ivashkin, V.S., *See* Burkov, P.A., 2:40821
Iwamoto, K., *See* Nomura, S., 2:41357
Iyengar, P.K., Indian experience in the training of manpower for nuclear power programme, 2:41306 (IAEA-CN—36/459)
Iyer, R.H., *See* Chaudhuri, N.K., 2:41866
Izrailev, Yu.L., *See* Plotkin, E.R., 2:41258

J

Jackson, M.R., *See* Rairden, J.R., 2:41814
Jacobson, A.R., Novel interferometer for the measurement of plasma density, 2:42226 (LA—6727-MS)
Jager, W., *See* Schroeder, E., 2:41507
Jain, K.C., Prevention of dust pollution from boilers, 2:41281
Jallade, M., *See* Delpeyroux, P., 2:41394
Janzen, S., Design, material and production - a complex problem within shipbuilding, 2:40935
Jarka, R.E., *See* Miller, L.B., 2:41536
Jarrett, J.H., *See* Fullam, H.T., 2:41155
Jasem, S., *See* Tseung, A.C.C., 2:41578
Jeffrey, D.C., *See* Salter, S.H., 2:41242
Jellinek, H.H., Osmosis process for producing energy, 2:41251
Jelovich, J.J., *See* Dufek, W.L., 2:41349
Jenkin, F.P., *See* Catchpole, S., 2:41302
Jenkins, C.R., *See* Pegg, W.J., 2:42122
Jenkins, G.T., *See* Miller, A., 2:42023
Jennings, J.W., *See* Eastwood, D.E., 2:40760
Jensen, L.M., Summary of space imagery studies in Utah and Nevada, 2:42142 (E—76-10420)
Jensen, P.A., The interrelationship of material toxicity, stream properties and quantity of spilled material in assessing the risk of hazardous material spills, 2:40991 (PB—259098)
Jiracek, G.R., Deep electrical resistivity investigations coupled with dry geothermal reservoir experiments in New Mexico. Technical progress report, 2:41235 (PB—258100)
Joechle, W., *See* Andersen, A.C., 2:42063
Johannisbauer, W., Plant for the liquid-liquid extraction of radioactive substances, 2:41100
Johanson, J., *See* Basu, S., 2:42179
John, T.M., *See* Pachovsky, R.A., 2:40956
Johnson, C.C., Radiofrequency radiation dosimetry handbook. Interim report 1 Jan—31 Jul 76, 2:42135 (AD-A—030874)
Johnson, H.R., Fabricating closed channels by electroforming, 2:41919
Johnson, J.R., Measurement of transuranic elements in vivo at CRNL, 2:42103 (BNWL—2088, pp 107-123)
Johnson, L.C., *See* Chu, T.K., 2:42217
Johnson, L.E., *See* Carter, H.R., 2:41342
Johnston, R.P., *See* Neitzel, R.E., 2:41743
Joly, G., *See* Brandt, R.C., 2:41334
Jonckheere, E., *See* van Dievoet, J., 2:41445
Jones, C., Synteny between the Pro^+ marker and human glutamate oxaloacetate transaminase, 2:42044
Jones, D.W., Mobile nuclear power plants: initial feasibility study. Research report, 2:41427 (PB—258232)
Jones, F.L., *See* Downs, W., 2:40900
Jones, J.E. Jr., *See* Hahn, O.J., 2:40778
Jones, J.M., Immunogenic and antigenic properties of a rat Moloney sarcoma, 2:42056
Jones, O.C. Jr., *See* Delhaye, J.M., 2:41312
Jones, W.R. Jr., Boundary lubrication of formulated C-ethers in air to 300°C. II. Organic additives, 2:41001
Judd, O., Effect of the addition of SF_6 to a N_2 electrical discharge laser, 2:41914
Juentgen, H., *See* Klein, J., 2:40846
Jueptner, G., Development of an integrated prestressed concrete vessel for water cooled reactors, 2:41324
Julian, E.C., *See* Kawahara, F.K., 2:40994
Jullien, R., Effect of spin fluctuations in actinide systems, 2:41771
Jung, J., *See* Kafka, F., 2:41471
Jung, R.G., *See* Mallozzi, P.J., 2:42312
Jungmann, A., Prestressed concrete pressure vessel with hot liner for PWR nuclear reactors, 2:41339
Just, W., *See* de Novion, C.H., 2:41832

K

Kachen, G.I., *See* Spalding, I.J., 2:42301
Kacznyski, V.W., *See* Buell, J.W., 2:40987
Kadlec, J., Turbulent temperature and pressure pulsations in longitudinal flow through rod bundles, 2:41453 (CS-INIS—30)
See Appelt, K.D., 2:41382
Kadota, K., *See* Fujita, J., 2:42271
Kaeding, L.R., *See* Kaya, C.M., 2:42115
Kaesberg, P., *See* Dasgupta, R., 2:42032
See Gupta, P., 2:42045
Kaesermann, P., Service experience with distribution transformers without oil conservators, 2:41288
Kafka, F., Element-type steam generators inspection with regard to operating reliability, 2:41471 (INIS-mf—3389, pp 52-55)
Kagami, H., *See* Yagi, E., 2:41098
Kahaner, D.K., *See* Tietjen, G.L., 2:42327
Kain, H.R., Life cycle costing for current Rohr and AM general buses and General Motors RTS-II bus. Final report, Mar 1976—Jul 1976, 2:41715 (PB—255091)
Kaiser, M.L., *See* Alexander, J.K., 2:42191
Kaiser, W.R., *See* Edgar, T.F., 2:40752
Kajita, T., Stress distributions of coils for toroidal magnetic field, 2:42294 (N—76-25020)
Kakodkar, A., *See* Challappa, S., 2:41307
See Mehta, S.K., 2:41370
Kalambokas, P.C., Representation of the light-water reflectors by boundary conditions, 2:41340
Kalmar, I., Turbocooling and no$sub x$-emission reduction of diesel engines, 2:41751
Kaluzienski, L.J., All-Sky Monitor observations of the decay of A0620-00 (Nova Monocerotis 1975), 2:42158 (N—76-28120)
See Holt, S.S., 2:42160
Kamfer, G.M., Thermodynamic model of the process of ignition in a diesel engine, 2:41677

Kamneva, A.I., *See* Aleksandrov, I.V., 2:40830
See Burkov, P.A., 2:40821
Kampmann, H.J., Effect of the stroke/bore ratio on the M diesel engine, 2:41744
Kannberg, L.D., *See* Gore, K.L., 2:41313, 2:41492
Kapinos, V.M., Heat transfer in the entrance section of a pipe with a two-phase flow, 2:41918
Kaplan, M.H., Nuclear powered satellite design for shuttle launches, 2:41157
Kapshukov, I.I., Structural changes in actinide dioxides under self- and reactor irradiation, 2:41857
See Sudakov, L.V., 2:41834
Karagodin, G.M., *See* Babkin, R.L., 2:40909
Karaseva, E.Z., Question of the study of the tendency of peats to undergo oxidation and spontaneous combustion, 2:40818
Karcher, K.E., *See* Onega, R.J., 2:41341
Kardos, Z.L., *See* Schmidt, D.K., 2:41424
Karim, D., *See* Arko, A.J., 2:41762
Kasai, S., *See* Tezuka, S., 2:41256
Kasen, M.B., *See* Reed, R.P., 2:41784
Katari, V., *See* Ponder, T.C. Jr, 2:41278
Katayama, N., *See* Kuriyama, Y., 2:41049
Katelyanov, B.Ya., Kinetics of the reaction of a coal-graphite material with oxygen, 2:40833
Kati, S.L., Reactivity requirements and safety systems for heavy water reactors, 2:41522 (IAEA-CN—36/393)
See Mehta, S.K., 2:41370
Katiyar, H.C., *See* Kondal Rao, N., 2:41086
Kato, Y., Coarse-mesh correction of the finite difference method for neutron diffusion calculations, 2:41416
Katsuta, H., Equilibrium pressure and solubility of hydrogen in liquid lithium, 2:42323
Katz, J.J., *See* Hoppe, W., 2:42027
Kaufmann, R.F., *See* Eadie, G.G., 2:41996
Kaul, D.C., *See* Miller, L.B., 2:41536
Kaushik, S.C., *See* Sodha, M.S., 2:42268
Kawahara, F.K., Characterization and identification of spilled residual fuel oils by gas chromatography and infrared spectrophotmetry, 2:40993
Characterization of heavy residual fuel oils and asphalts by infrared spectrophotometry using statistical discriminant function analysis, 2:40994
Kawahata, K., *See* Fujita, J., 2:42271
Kawam, A., *See* Smith, L.M., 2:40850
Kaya, C.M., Use of a cold-water refuge by rainbow and brown trout in a geothermally heated stream, 2:42115
Kazachkovskii, O.D., USSR fast reactor development program and its current state, 2:41398 (IAEA-CN—36/356)
Kazimi, M.S., *See* Tsai, S.S., 2:41551
Kazmerski, L.L., Ternary compound thin film solar cells. Quarterly report No. 3, 1 Mar—31 May 76, 2:41190 (PB—256254)
Keilholtz, G.W., *See* Buchanan, J.R., 2:41532
Keller, C., ^{129}I as an example: problems of reprocessing, 2:41101
Keller, D.V., Carbon ribbon gauge for electron beam diagnostics. Final report, 2:41926 (AD-A—026905)
Keller, D.V. Jr., *See* McClure, J.C. Jr., 2:40843
Keller, G.V., *See* Grose, L.T., 2:41234
Keller, R., *See* Pochelon, A., 2:42245
Kellermann, O., *See* Birkhofer, A., 2:41515
Kelley, A.P. Jr., Gas-cooled fast breeder reactor accident initiation and progression analysis. Progress report, July 1, 1975—June 30, 1976, 2:41510 (GA-A—14079)
Kelly, H.J., *See* Bruzzone, H.A., 2:42238
Kelman, B.J., Methylmercury movements across the perfused guinea pig placenta in late gestation, 2:42058
Kennedy, R.H., Management and control of radioactive wastes from uranium-milling operations, 2:41125 (IAEA-CN—36/479)
Kessler, G., Safety of the liquid metal cooled fast breeder reactor and aspects of its fuel cycle, 2:41529 (IAEA-CN—36/572)
See Bailly, J., 2:41519
See Daeunert, U., 2:41404
Ketterson, J.B., *See* Arko, A.J., 2:41762
Keyes, J.H., Method and equipment to collect and store solar energy, 2:41218
Khan, A.A., *See* Thomas, K.T., 2:41123
Khan, B.K., *See* Basu, S., 2:42175
Khandelwal, G.S., *See* Singh, J.J., 2:40986
Kharlamov, V.V., *See* Kondrashin, A.V., 2:41271
Khasanov, Z.K., *See* Kondrat'ev, A.A., 2:40942
Khiis, V., *See* Turbas, E., 2:41069
Khrunov, Y.V., *See* Lazarev, A.I., 2:42172
Kietzer, K., Safety analysis of the THTR-300 MW(e)-prototype-reactor and future HTR's under extreme accident conditions, 2:41528 (IAEA-CN—36/560)
Kikuchi, T., *See* Kirihara, T., 2:41858
Kikuchi, Y., Evaluation of local accidents in LMFBR, 2:41527 (IAEA-CN—36/551)
Kilkenny, J.D., Limitations on the radical acceleration of a plasma formed by an intense relativistic electron beam, 2:42242
Kim, D.K., *See* Brooks, J.A., 2:40796
Kimball, R.F., Reversions of two proline-requiring auxotrophs of Haemophilus influenzae by N-methyl-N′-nitro-N-nitrosoguanidine and hydrazine, 2:42050
Kimura, H., *See* Sanada, Y., 2:40736
King, N.S.P., *See* Chang, H.H., 2:42202
King, S.B., *See* Eastwood, D.E., 2:40760
See Fischer, D.D., 2:40772
Kintner, P.M., Observations of ion cyclotron waves within the plasmasphere by Hawkeye-1. Progress report, 2:42190 (AD-A—034783)
Kirby, C.E., *See* Allred, J.W., 2:41204
Kirihara, T., Fission dose dependence of the lattice parameter change in fuel elements, 2:41858
See Inoue, T., 2:41856
Kirillov, I.I., *See* Siryi, P.O., 2:41267
Kirkham, I.A., *See* Chilton, G.R., 2:41826
Kirkwood, P.R., *See* Garland, J.G., 2:41758
Kirsanova, T.I., *See* Chertkov, Ya.B., 2:40963, 2:40967
Kirsch, E., *See* Rossberg, L., 2:42192
Kirschner, D.A., Neutron diffraction studies of nerve myelin, 2:42021 (BNL—50453, pp III.68-III.76)
Kiselev, G.V., *See* Kazachkovskii, O.D., 2:41398
Kissell, F.N., *See* Moore, T.D. Jr., 2:40881
Kitsunezaki, A., *See* Yoshida, Y., 2:42293
Kjaer-Pedersen, N., *See* Knudsen, P., 2:41487
Kjarmo, H.E., *See* Merz, M.D., 2:41789, 2:41790
Klapper, M.H., *See* Clement, J.R., 2:42072
Klaus, E.E., *See* Barton, D.B., 2:41009
Klein, J., Studies of the emission of elemental nitrogen from coals of different rank and its release under geochemical conditions, 2:40846
Kleinhenz, T.A., *See* Mosby, J.F., 2:40958
Kleinhofs, A., *See* Sander, C., 2:42043
Kleinkauf, W., Electric power-conditioning for a thermionic generator, 2:41428
Klesment, I.R., *See* Pobul, L.Ya., 2:41065
Klevans, E.H., *See* York, T.M., 2:42212
Klingberg, M.A., *See* Aharonson, E.F., 2:42127
Klyuchnikov, A.T., *See* Glebov, I.A., 2:41560
Knapek, E., *See* Dietrich, I., 2:41884
Knapp, G.S., *See* Trainor, R.J., 2:41807
Kniazewycz, B.G., Role of volume reduction processes in LWR radwaste treatment, 2:41326
Knickmeyer, W., Roadheading technique at the 9th World Mining Congress, 2:40897
Knoedler, D., *See* Holzer, R., 2:41083
Knudsen, P., Performance evaluation of UO_2-Zr fuel in power ramp tests, 2:41487 (IAEA-CN—36/203)
Knurenko, V.A., *See* Korshunov, A.N., 2:40883
Kobayashi, T., Optimum design of the poloidal field coils of a large fusion device, 2:42292 (JAERI-M—6451)
See Kobayashi, T., 2:42292
See Tani, K., 2:42303
See Yoshida, Y., 2:42293
Koch, L., *See* Cecille, L., 2:41133
Koch, P.K., *See* Rouse, C.A., 2:41383
Kochetkov, L.A., *See* Kazachkovskii, O.D., 2:41398
Kochetkova, T.V., *See* Sabadash, Yu.S., 2:40980
Kocourek, E., *See* Baschek, H., 2:41480
Kodama, Y., *See* Hasegawa, A., 2:42281
Koefoed, O., Application of electromagnetic frequency sounding to groundwater problems, 2:42144
Recent developments in the direct interpretation of resistivity soundings, 2:41939
Koelling, D.D., Electronic energy band structure of actinide metals and intermetallics, 2:41772
Koga, R., Solution of the fuel burnup control problem with a controlling neutron equation and Walsh functions, 2:41461
Kogan, L.O., *See* Polyakova, A.A., 2:40966
Kohno, T., *See* Kuriyama, Y., 2:41049
Koizumi, M., *See* Muto, T., 2:41489
Kok, B., Biological solar energy conversion: approaches to overcome yield, stability and product limitations. Progress report No. 3, 1 Apr 1976—30 Sep 1976, 2:41198 (PB—261910)
Kokorin, I.N., *See* Spitsyn, V.I., 2:41139
Kolesnichenko, Ya.I., *See* Belikov, V.S., 2:42248
Kolmakov, O.A., *See* Demirkhanov, R.A., 2:42256
Kolos, J., *See* Duesing, G., 2:42297
Kolstad, E., *See* Firing, J.A., 2:41488
Kolychev, B.S., *See* Dolgov, V.V., 2:41122
Kolyer, J.M., Accelerated/abbreviated test methods, study 4 of task 3 (encapsulation) of the low-cost silicon solar array project. Third quarterly progress report, October—December 1976, 2:41183 (ERDA/JPL/954458—76/3)
Kolykhan, L.I., *See* Krasin, A.K., 2:41397
Komarov, V.A., *See* Kamfer, G.M., 2:41677
Kondal Rao, N., Integrated planning for a fuel industry with emphasis on minimum size to fabricate own fuel, 2:41086 (IAEA-CN—36/386)
Kondrashin, A.V., Application of the factorial experiment to the analysis of the effectiveness of control systems, 2:41271
Kondrat'ev, A.A., Computer simulation of tower operation with two and three crude oil feed inlets, for partial topping of crude, 2:40942
Kondrat'ev, A.N., Spent fuel transportation problems, 2:41108 (IAEA-CN—36/316)
Konstantinovich, A.A., *See* Dolgov, V.V., 2:41122
Kooijman, W., *See* Mimura, M., 2:42247
Koopman, R.P., *See* Dietrich, F.S., 2:42200

Kopecky, J., Study of the $^{238}U(n,\gamma)^{239}U$ reaction, 2:42206 (INIS-mf—3352, pp 15)
Kopp, H., *See* Jungmann, A., 2:41339
Korotkov, P.I., *See* Pikalov, G.P., 2:40945
Korovkina, L.A., *See* Zil'berbrandt, A.M., 2:40800
Korsak, A.J., Station simulation studies for personalized rapid transit urban development, 2:41705
Korshunov, A.N., Coal cutting with a disk, 2:40885
Influence of vibration parameters on the process of advancing a shield-type support, 2:40883
Korsov, Yu.G., *See* Siryi, P.O., 2:41267
Korzh, M.V., *See* Zonn, M.S., 2:40922
Kosarev, Yu.A., *See* Kondrat'ev, A.N., 2:41108
Kostadinov, K., Experience of NPS construction in the People's Republic of Bulgaria, 2:41332 (IAEA-CN—36/537)
Kostka, H., Method for production of a gas mixture using a catalytically converted fuel and a gas serving as oxygen carrier, 2:41754
Kostyuk, O.E., *See* Chebotarev, N.T., 2:41765
Kosyak, Yu.F., *See* Margulova, T.Kh., 2:41479
Kotel'nikov, R.B., *See* Reshetnikov, F.G., 2:41085
Koura, K., *See* Walsh, W.J., 2:41577
Kovalev, S.D., *See* Krasin, A.K., 2:41397
See Nesterenko, V.B., 2:41521
Krakowski, R.A., Experiments towards a toroidal-theta-pinch fusion reactor, 2:42283
Kralik, W.A., Changes in an electric utility's fuel base, 2:41653
Krasin, A.K., Basic performance problems and prospects for 1200-1500 Mw gas-cooled fast reactors with the dissociating coolant, 2:41397 (IAEA-CN—36/332)
Krawiec, A., *See* Wegrzyk, Z., 2:40888
Kreffer, P., *See* Drouet, M.G., 2:42244
Kreher, K., Reconstruction of the pump storage station Bleiloch, East Germany, with simultaneous output increase, 2:41561
Kreith, F., *See* Nannen, L.W., 2:41237
Kremenchugskii, V.M., *See* Plotkin, E.R., 2:41258
Kress, T.S., *See* Fontana, M.H., 2:41533
Kreuzer, J., Standard transformers for 2 to 100 MVA, 2:41287
Krichko, A.A., *See* Gagarin, S.G., 2:40744
Kriechbaum, K., Philippsburg nuclear power plant 380 KV switching station, 2:41314 (CS-INIS—27)
Krishnan, T.S., *See* Kondal Rao, N., 2:41086
Kroenke, W.C., Interpretation of finite element stresses according to ASME Section III, 2:41477
Krohn, K., *See* Parks, N.J., 2:42125
Krokhin, O.N., *See* Basov, N.G., 2:42221
Krokhin, V.A., *See* Markov, N.M., 2:41257
Krol', A.Ya., *See* Plotkin, E.R., 2:41258
Krol', G.V., *See* Tarasov, B.G., 2:40865
Krommes, J.A., Renormalized kinetic theories of anomalous transport due to hydrodynamic fluctuations in strongly magnetized plasma, 2:42237
See Cohen, B.I., 2:42250
Kroup, M., *See* Gal, J., 2:41770, 2:41799
Krueger, P., *See* Pillsticker, M., 2:42300
Krueger, W., *See* Appelt, K.D., 2:41382
Kruger, J., The role of passive film growth kinetics and properties in stress corrosion and crevice corrosion susceptibility. Technical summary report No. 7, Oct 1975—Nov 1976, 2:41812 (AD-A—034723)
Kruger, O.L., Heat transport properties of a delta-stabilized Pu-1 wt.% Ga alloy from room temperature to 500 degrees C, 2:41800
See Alexander, C.A., 2:41838
Kruger, P., *See* Kuo, M.T., 2:42139
Kruglov, B.V., *See* Basov, N.G., 2:42221
Krugov, V.B., *See* Bodrov, I.S., 2:41268
Kruppa, C., *See* Clauss, G., 2:40997
Kulacki, F.A., *See* Baker, L. Jr., 2:41549
Kulakovskii, M.Ya., *See* Bakumenko, O.D., 2:41396
Kuldkepp, P., *See* Turbas, E., 2:41069
Kulesh, N.I., Oxidative-reductive transformations of the quinoid groups of humic acids, 2:41875
Kulhanek, F.C., Pressure-sensitive release mechanism for radiosonde applications, 2:41956 (ANL—75-60(Pt.4), pp 31-33)
Kulichenko, V.V., *See* Dolgov, V.V., 2:41122
Kulik, P., *See* Kriechbaum, K., 2:41314
Kulpa, C.F., *See* Edwards, H.E., 2:42037
Kumar, K.D., *See* Adams, S.M., 2:41494
Kummer, D.L., Low activation materials assessment for fusion reactors, 2:42315 (EPRI-ER—328-SR)
Kumpf, H., *See* Jueptner, G., 2:41324
Kunhardt, E.E., Experimental and theoretical study of the propagation of high amplitude pulses in a bounded magneto-plasma, 2:42258
Kuo, M.T., Heat and mass transfer in porous rock fragments, 2:42139 (PB—258102)
Kupka, I., *See* Becka, J., 2:41374
Kurasawa, T., *See* Nasu, S., 2:41843
Kurbatov, A.V., *See* Filonenko, Yu.Ya., 2:40827
Kurehashi, T., *See* Kuriyama, Y., 2:41049
Kurilyama, T., *See* Kuriyama, Y., 2:41049
Kuriyama, Y., Automatic welding for an LNG storage tank of 9% nickel steel, 2:41049
Kuroda, T., *See* Fujita, J., 2:42271
Kushakovskii, V.I., *See* Reshetnikov, F.G., 2:41085
Kusuda, T., Analysis of solar energy system for the GSA demonstration office building at Manchester, New Hampshire. Final report, 2:41211 (PB—254179)
Effect of ground cover on Earth temperature, 2:41596 (NSF-RA—760006, pp 279-303)
Kusunoki, J., *See* Shimazu, H., 2:41548
Kuwabara, T., *See* Araki, M., 2:41177
Kuz'min, V.I., *See* Zaimovskii, A.S., 2:41444
Kydes, A., *See* Bodin, L., 2:41703
Kyuregyan, S.K., Curtailment of time required to determine gasoline induction period, 2:40964

L

La Celle, P.L., *See* Evans, E.A., 2:42040
La Villa, F., *See* Madec, M., 2:41000
Labavitch, J.M., Structure of plant cell walls. Purification and characterization of a β-1,4-galactanase which degrades a structural component of the primary cell walls of dicots, 2:42036
Labaw, P., *See* Rappeport, M., 2:41617, 2:41618, 2:41619, 2:41620, 2:41621, 2:41622, 2:41623, 2:41625
Labs, K., Use of earth covered buildings through history, 2:41588 (NSF-RA—760006, pp 7-19)
LaCelle, P.L., *See* Chan, T.K., 2:42028
Lacewell, R.D., Effect of changing input and product prices on the demand for irrigation water in Texas. Technical report, 2:41586 (PB—255731)
Lachere, G., *See* Bonnelle, C., 2:41763
Lacks, S., Binding and entry of DNA in pneumococcal transformation, 2:42034
Single-strand breakage on binding of DNA to cells in the genetic transformation of Diplococcus pneumoniae, 2:42048
LaConti, A.B., *See* Dempsey, R.M., 2:40913
Ladikov, Yu.P., Reactor control system by means of neutral-beam injection, 2:42321
Lam, D.J., *See* Veal, B.W., 2:41849
Lambert, A.J.D., Damping and dispersion of linear longitudinal oscillations in a multi-component plasma, 2:42262
Lambert, R.A., *See* Matzke, H., 2:41853
Lammert, J.E., *See* Chrisp, C.E., 2:42121
Land, R.E., Modeling the effect of inventory loss on steam generator heat transfer, 2:41343
Lane, K., *See* Neuman, M.W., 2:42054
Lane, S.S., Applications of higher mode surface waves. Technical report, 2:41947 (AD-A—034883)
Lang, W., *See* Kadlec, J., 2:41453
LaNier, R., Earth-covered buildings and environmental impact, 2:41595 (NSF-RA—760006, pp 269-278)
Lanning, W.C., Alternative liquid fuels and the ERDA program, 2:41639
Lansdown, A.R., Lubricant chemistry, 2:40972
Lansing, F.L., The transient thermal response of a tubular solar collector, 2:41227 (N—76-28649)
Lanum, W.J., *See* Eastwood, D.E., 2:40760
Lanzerotti, L.J., *See* Sturrock, P.A., 2:42165
Larew, H.G., *See* Smith, L.M., 2:40850
Larionov, M.M., *See* Vlasenkov, V.S., 2:42288
Larrick, A.P., Waste management implications of irradiated nuclear fuel storage, 2:41104 (IAEA-CN—36/23)
Larsson, A., Management of radioactive waste and plutonium in the Swedish perspective, 2:41128 (IAEA-CN—36/554)
Larsson, Y., *See* Hannerz, K., 2:41448
Lasek, K., *See* Romanczyk, E., 2:40902
Lathrop, K.A., Need for collection of quantitative distribution data for dosimetry and metabolic modeling, 2:42084 (CONF-770101—2)
Latimer, I.S. Jr., Contribution of ERTS-B to natural resource protection and recreational development in West Virginia. Progress report No. 3, 19 Mar—19 Jun 76, 2:40853 (E—76-10445)
Laughton, A.S., *See* Mitchell, N.T., 2:41136
Laurer, G.R., Detection system for the localization and measurement in vivo of small amounts of photon emitters, 2:42111 (BNWL—2088, pp 207-218)
See Cohen, N., 2:42107
Lavergne, J.C., *See* Vogelweith, L., 2:41333
Lazarev, A.I., Optical observations from the Voskhod-2 spacecraft, 2:42172 (N—76-28122)
Lazarev, L.N., *See* Blinov, V.A., 2:41140
Lazarev, V.D., Investigation of some physicochemical processes in pitch-coke compositions, 2:40829
Le Gall, Y., *See* Perret, J., 2:41293
Leavell, W.H., *See* Sheppard, J.D., 2:41534
Lebl, P., In-service inspection of life and reliability of pipe system of WWER 1000 primary circuit, 2:41335 (INIS-mf—3389, pp 31-45)
Ledbetter, H.M., *See* Reed, R.P., 2:41784
Lee, J.A., *See* McElroy, D.L., 2:41841
Lee, M., Dynamic load amplification factors for safety valve headers, 2:41478
Lee, N.T., *See* Clement, J.R., 2:42072

Lee, R.B., *See* Wachter, W.J., 2:41483
Lee, T., On shallow-hole temperature measurements--a test study in the Salton Sea geothermal field, 2:41236 (PB—262643)
Lee, W.N., NOVA-2: a digital computer program for analyzing nuclear overpressure effects on aircraft. Part 2. Computer program. Final report, 2:41943 (AD-A—029389)
Lee, Y.J., Sodium heated steam generator tube wastage due to water/steam to sodium leaks--theory and correlation, 2:41420
Lees, D.J., *See* Atkinson, D.W., 2:42211
Lefranc, G., *See* Dietrich, I., 2:41884
Legasov, V.A., *See* Aleksandrov, A.P., 2:41438
Lehmann, E.J., Water pollution analysis and detection. Volume 2. July 1974—January 1977 (a bibliography with abstracts). Report for Jul 1974—Jan 1977, 2:42007 (NTIS/PS—77/0027)
Lehnert, B., A note on the problems of plasma-neutral gas interaction, 2:42236 (N—76-31018)
Data on rotating plasma operation in Tornado traps, 2:42322
Lehr, J., Hearing conservation program prototype phase final report. Technical report, 2:42136 (AD-A—030896)
Leighton, G.S., New energy economics and the role of energy conservation in buildings, 2:41611 (NSF-RA—760006, pp 79-84)
Leighton, H.I., Solar—geophysical data number 387. Part II. Comprehensive reports. Data for May 1976—April 1976 and miscellanea. Explanation of data reports issued as number 378 (supplement) February 1976, 2:42170 (PB—263007)
Solar—geophysical data number 387. Part I. Prompt reports. Data for October 1976—September 1976. Explanation of data reports issued as number 378 (supplement) February 1976, 2:42171 (PB—263008)
Leininger, D., Coal preparation technique at 'Bergbau '76', 2:40905
Leiteritz, H., *See* Bentrup, F.K., 2:40895
Lemaire, J.F., *See* Burlaga, L.F., 2:42174
Lengyel, L.L., Effect of wavelength on absorption and ionization of laser-produced plasmas in magnetic fields with allowance for finite rate ionization and recombination, 2:42313
Leo, R., *See* Campolunghi, F., 2:41410
Leonov, O.B., Theoretical and experimental determination of instantaneous air flow in a combined diesel in unsteady conditions, 2:41718
Leontichuk, A.S., *See* Spitsyn, V.I., 2:41139
Lerner, T.H., *See* Blais, R.N., 2:41962
Leshane, A.A., *See* Gobetz, F.W., 2:41606
Leshchenko, V.E., *See* Borisov, A.V., 2:40925
Letokhov, V.S., *See* Chekalin, N.V., 2:41916
Levallet, E.H., Rapsodie: A closed fuel cycle, 2:41393 (IAEA-CN—36/266)
Levene, B., National air sampling network. Status report, 2:41966 (PB—255288)
Levin, I.S., Investigation of the composition and possible methods of using extracts of tertiary brown coals of the Southern Urals Basin, 2:40809
Levine, H.L., *See* Zahradnik, J.W., 2:41699
Levine, M.J., *See* Thornton, S.T., 2:42205
Levinson, G.I., *See* Kyuregyan, S.K., 2:40964
Levit, A.G., *See* Rozenblit, G.B., 2:41713
Levitz, N., *See* Allen, J., 2:41231
Levoshchenko, A.A., *See* Kondrashin, A.V., 2:41271
Lew, S.T., *See* Dunn, W.L., 2:41535
Lewis, P., *See* Taylor, R., 2:41897
Ley, R.D., Photosensitizing effects of 8-methoxypsoralen on the skin of hairless mice. I. Formation of interstrand cross-links in epidermal DNA, 2:42083
Lezenik, B., Arguments for the installation of small LWR nuclear power plants in developing countries, 2:41315 (IAEA-CN—36/89)
Li, C.H., M551 metals melting experiment, 2:41757 (N—76-27401)
Lichtman, M.A., Use of a single venous blood sample to assess oxygen binding to haemoglobin, 2:42038
See Brennan, J.K., 2:42053
Lievano, R.J., *See* Thompson, R.G., 2:41638
Lifanova, T.A., *See* Chertkov, Ya.B., 2:40963, 2:40967
Lijinsky, W., *See* Singer, G.M., 2:41867
Lilliehook, B., *See* Lundegardh, G., 2:42071
Lin, J.H., *See* Peterson, R.E., 2:41226
Lin, Y.T., *See* Advani, S.H., 2:40765
Linari, A., *See* Mangiagalli, D., 2:41320
Lind, J., *See* Larsson, A., 2:41128
Lindemer, T.B., *See* Pearson, R.L., 2:41361
Lindmayer, J., Development of 20% efficient solar cell. Final project report 1 Jun 74—31 Aug 75, 2:41189 (PB—255903)
Lindner, R., *See* Blank, H., 2:41399
Lindner, W., *See* Alexas, A., 2:41851
Lion, H.I., *See* Kopecky, J., 2:42206
Lipschutz, R.C., Sangamon Experiment: geostrophic wind profiles, 2:41954 (ANL—75-60(Pt.4), pp 16-21)
See Wesely, M.L., 2:41179
Lishtvan, I.I., Investigations of the bitumens of solid fuels under the electron microscope, 2:40807
Lisitsyn, V.N., *See* Ishchenko, V.N., 2:41915
Lister, J.B., *See* Atkinson, D.W., 2:42211
Liu, M.S., Fluidized bed solids waste gasifier, 2:41172
Liu, S.T., *See* Kusuda, T., 2:41211
Lo, R., *See* Young, J.E., 2:40776
Loftis, B., *See* Dortch, M.S., 2:41557
Lofy, R.J., *See* Rosenberg, D.G., 2:40990
Logan, S.E., *See* Goldberg, S.M., 2:41113
Logg, C.A., DPAK and HPAK: a versatile display and histogramming package, 2:42330 (SLAC—196)
Logov, A.B., *See* Korshunov, A.N., 2:40885
Lokhman, V.N., *See* Chekalin, N.V., 2:41916
Lominadze, J.G., *See* Chen, L., 2:42246
Long, K.A., Alloying, radiation damage, and Matthiessen's rule in plutonium, 2:41801
Role of lattice vibrations in the determination of the physical properties of the actinides, 2:41773
Lonngren, K.E., Expansion of an electron cloud, 2:42243
Lopachenok, L.V., Porous structure and specific surface of combustible shale, 2:41066
Lopez Perez, B., Spanish program on disposal of radioactive wastes, 2:41118 (IAEA-CN—36/206)
Lorenz, S., *See* Hoppe, W., 2:42027
Lotts, A.L., HTGR fuel and fuel cycle technology, 2:41359 (IAEA-CN—36/578)
Lough, C.E., *See* Holmes, H.L., 2:41871
Lowe, A.L. Jr, *See* Van Der Sluys, W.A., 2:41783
Lowell, P.S., *See* Brown, G.D., 2:41976
Lowen, D.J., Development of a solar powered residential air conditioner (general optimization). Final report, 2:41203 (N—76-24702)
Lozovoy, Yu.A., *See* Sanin, P.I., 2:41003
Lubin, M.J., Fusion reactor and operating process, 2:42280
Luchter, S., Assessment of the technology of Rankine engines for automobiles, 2:41726 (ERDA—77-54)
Ludemann, W.D., *See* Beitscher, S., 2:41089
Ludwick, J.S. Jr., Bus priority system simulator, 2:41706
Luhmann, N.C. Jr, Waves and instabilities in steady-state high-beta plasmas. Final report 15 May 72—30 Jun 76, 2:42254 (AD-A—030924)
Luk, C., Effects of the steam chest on steamhammer analysis for nuclear piping systems, 2:41476
Lukashenko, I.M., *See* Brodskii, E.S., 2:40968
Lukovnikov, A.F., *See* Davydova, Zh.A., 2:40831
Lundahl, C.R., An investigation of the acceptance of solar heating and cooling in the housing industry in New Mexico. Final technical report, 1 Aug 1975—31 Jul 1976, 2:41205 (N—76-28652)
Lundegardh, G., Inhibition of erythroid cell growth in irradiated mice by allogeneic lymphoid cells: specificity of the response, 2:42071
Lynch, P.F., Identifying source of petroleum by infrared spectroscopy, 2:40992
Lysell, G., *See* Mogard, H., 2:41520
Lytkin, V.B., *See* Kazachkovskii, O.D., 2:41398
Lytton, R.L., Soil and ground water considerations, 2:41594 (NSF-RA—760006, pp 257-262)
Lyubtsev, R.I., *See* Galkin, B.Ya., 2:41132
Lyutina, E.M., *See* Gromozov, L.I., 2:41787

M

Macek, A., Flammability limits: thermodynamics and kinetics. Final report, 2:41030 (PB—254180)
Machugovskii, N.B., *See* Iokhel'son, Z.M., 2:40891
MacKenzie, E., *See* Basu, S., 2:42179
Macklin, R.L., *See* de Musgrove, A.R. L., 2:42204
MacLean, S.C., DT fusion neutron irradiation of LLL "tritium-tricked" niobium, BNL—LASL superconductor wires, BPNL wire-foil packages, 2:42320 (UCID—17431)
MacMillan, K.L., *See* Holbrook, C.H., 2:42088
Madec, M., Lead traces titration in naphthas, 2:41000
Madsen, S.E., *See* Coykendall, R.E., 2:41607
Maeda, M., *See* Yagi, E., 2:41098
Maekawa, H., Preliminary results of integral experiment on fusion-fission hybrid blanket assemblies, 2:42287 (JAERI-M—6495)
Maerk, E., *See* Sato, N., 2:42267
Maerker, R.E., Measurements and calculations of neutron fluxes through a simulation of the CRBR upper axial shielding, 2:41380 (CONF-770401—8)
Magera, M., Quality assurance of production of steam generators and volume compensators for WWER-440 type nuclear power plants, 2:41336 (INIS-mf—3389, pp 46-51)
Maheshwari, S.L., Frictional effects with neutrals and Rayleigh-Taylor instability of a compressible Hall plasma, 2:42252
Maidl, J., *See* Gross, K., 2:41727
Maines, I.S., *See* Araktingi, Y.E., 2:41014
Makarchenko, V.G., *See* Averina, M.V., 2:40960

Makarov, I.I., Stratified flows produced upon discharge of hot power-plant effluents into cooling ponds and rivers, 2:41498
Makarov, V.M., *See* Reshetnikov, F.G., 2:41085
Maksimov, O.B., *See* Kulesh, N.I., 2:41875
Malein, A., *See* Atkinson, D.W., 2:42211
Mallem, O., *See* Martinuzzi, S., 2:41195
Mallozzi, P.J., Current status of laser fusion research at Battelle, 2:42312
Malyavinskii, L.V., Influence of diesel fuel cetane number on operating indices of engine, 2:41723
Maman, A., In-pile gamma scanning. Application to power and burnup measurement and to the study of fission product migration, 2:41486 (CEA-CONF—3663)
Mamaros, T.C., *See* Delameter, W.R., 2:41880
Mamelle, J., *See* Redon, A., 2:41119
Mandahl, B., Handling of waste at Swedish nuclear power plants, 2:41121 (IAEA-CN—36/282)
Manes, K.R., *See* Ahlstrom, H.G., 2:42308
Manes, L., Electronic properties of actinide oxides, 2:41829
Unified model for defects in substoichiometric plutonium dioxide and uranium plutonium mixed oxides, 2:41828
See Naegele, J., 2:41842
Manes-Pozzi, B., *See* Manes, L., 2:41828
Mangiagalli, D., Pu utilization in fast-breeder and in light-water reactors in Italy, 2:41320 (IAEA-CN—36/577)
Manheimer, W.M., Efficient laser light absorption by ion acoustic fluctuations. Interim report, 2:42305 (AD-A—034450)
Manion, P.J., Downstream movement of fish in a tributary of southern Lake Superior, 2:42116
Manko, H., *See* Davis, J.M., 2:41929
Mann, B.J., Review of state licenses for disposal of low-level radioactive waste by shallow land burial. Technical note, 2:41141 (PB—258259)
Mann, J.R., *See* Thompson, P.N., 2:40775
Mannone, F., *See* Cecille, L., 2:41133
Manor, S., *See* Adar, J., 2:41447
Mansky, J., *See* Brennan, J.K., 2:42053
Mantlik, F., Local hydrodynamic characteristics of regular triangular lattice of rods, 2:41458 (UJV—3778-R)
Marcol, J., Effect of mining on methane emission and concentration in return air, 2:40889
Marder, L.I., *See* Arzamastsev, D.A., 2:41275
Mardon, P.G., *See* Haines, H.R., 2:41827
Margen, P., *See* Hannerz, K., 2:41448
Margulova, T.Kh., Water chemistry conditions of saturated steam turbines, 2:41479
Markel, L.C., *See* Miles, W.T., 2:41446
Markley, D.J., *See* Eadie, G.G., 2:41996
Markley, R.A., *See* Minushkin, B., 2:41421
Markov, N.M., Mastering the steam-and-gas 200 MW power unit and prospects of application of high-capacity steam-and-gas plants in power generation, 2:41257
See Siryi, P.O., 2:41267
Markovskii, N.I., Oil in the mouths of rivers, 2:40928 (N—76-27643)
Marks, G.J., *See* Kain, H.R., 2:41715
Marks, S., Plutonium problem in biological perspective, 2:42094 (BNWL—2088, pp 1-10)
Marples, J.A.C., Low temperature lattice parameters of the actinide dioxides, 2:41830
Marris, J.H.S., *See* McHugh, J., 2:41043
Marsh, J.R., *See* Stone, R., 2:42012
Marshall, A.C., Evaluation of Fort St. Vrain nuclear analysis methods, 2:41353 (GA-A—14007)
Marshall, J.E., Power from urban refuse, 2:41260
Martin, J.E., *See* Clement, M., 2:42225
Martin, J.W., *See* Shuck, L.Z., 2:40750, 2:40779
Martin, K.R., *See* Wier, C.E., 2:40869
Martin, T.G. III, Result of the assay of radiation sterilized beef for induced radioactivity. Technical report, 2:42075 (AD-A—030785)
Martines Martinez, A., *See* Lopez Perez, B., 2:41118
Martinot, G., *See* Vogelweith, L., 2:41333
Martinuzzi, S., Dark currents in cuCu_2S-CdS single crystal heterojunctions--consequences for photocells, 2:41195
Martynov, Yu.P., *See* Dolgov, V.V., 2:41122
Maruhn, J.A., Time-dependent Hartree-Fock calculation of $^{12}C + ^{12}C$ with a realistic potential, 2:42199
Maslowski, S.F., *See* Holbrook, C.H., 2:42088
Mason, R.Z., Economic comparison of producing SNG by Lawrence Livermore Laboratory's in situ coal gasification process with Lurgi aboveground coal gasification, 2:40758 (MERC/SP—76/3, pp 188-213)
Mason, S.B., *See* Chodzko, R.A., 2:41891
Massoudi, H., *See* Johnson, C.C., 2:42135
Matarazzi, B., *See* Schmidt, B., 2:41740
Mathews, D.R., *See* Rouse, C.A., 2:41383
Matijevic, V., Design of control systems for electric power systems, 2:41269
Matsui, H., *See* Inoue, T., 2:41856
See Kirihara, T., 2:41858
See Nasu, S., 2:41843
Matsuoka, K., *See* Fujita, J., 2:42271
Matsuura, K., *See* Fujita, J., 2:42271
Matyskin, V.I., *See* Bychev, M.I., 2:40826
Matzke, H., Gradients of U, Pu and O at surfaces of (U, Pu)Osub(2+-x), 2:41853
Lattice defects and irradiation damage in ThO_2, UO_2 and $(U,Pu)O_2$, 2:41854
See Blank, H., 2:41399
Mauer, A., Using electronic data processing equipment for complotting supply grids, 2:41290
Mautref, M., *See* Fabre, E., 2:41193
May, R., *See* Hoppe, W., 2:42027
Mayer, A., Electroless or autocatalytic coating of microparticles for laser fusion targets, 2:41147 (LA—6583)
Electrolytic coating of microparticles for laser fusion targets, 2:41148 (LA—6584)
See Fries, R.J., 2:41149
Mayer, J.T., *See* Tulenko, J.S., 2:41346
Mayman, S.A., *See* Tomlinson, M., 2:41116
Mcalees, D.G., ORNL-EPR study--results and implications, 2:42291
McCain, J.D., *See* Gooding, C.H., 2:41279
McCarthy, G.J., Advanced waste forms research and development. Comprehensive progress report, 2:41130 (COO—2510-12)
McCawley, F.X., *See* Schlain, D., 2:41816
McClure, J.C. Jr., Adhesion of micron sized coal particles to a massive coal substrate, 2:40843
McColgan, E.C., Hydrocracking of residual oils and tars. I. The effect of feed dilution on the thermal hydrocracking of Athabasca bitumen, 2:41059
Hydrocracking of residual oils and tars. II. The catalytic hydrocracking of Athabasca bitumen, 2:41060
Hydrocracking of residual oils and tars. IV. Catalyst de-activation with bitumens from Athabasca, Cold Lake, and Lloydminster, 2:41062
Hydrocracking of residual oils and tars. V. Surface-coated cobalt molybdate catalysts for hydro-treating, 2:41063
See Soutar, P.S., 2:41057, 2:41061
McCone, A.I., *See* Buder, M.K., 2:40754
McConnell, B.S., *See* Dunn, W.L., 2:41535
McCormick, F., *See* Smith, L.M., 2:40850
McCreary, W.J., *See* Fries, R.J., 2:41149
McCullough, D.G., *See* Taft, P.H., 2:41232
McCutcheon, E.B., Simulation for control synthesis of a plutonium—uranium extraction process, 2:41094 (IS-M—25)
McDaniel, E.W., *See* Barnett, C.F., 2:42231
McDaniel, T.L., *See* Chulick, E.T., 2:41347
Mcdermott, P.P., Cadmium migration in aerospace nickel cadmium cells, 2:41571 (N—76-24703)
McDonald, C.K., Seismic analysis of vertical pumps enclosed in liquid filled containers, 2:41540
McElroy, D.L., Specific heat of PuCsub(1-x) and Pu_2C_3 from 10 to 300 K, 2:41841
McFarland, A.R., Fractionator for size-classification of aerosolized solid particulate matter, 2:42119 (UCD—472-123, pp 2-4)
McFarland, B., *See* Galluzzo, N.G., 2:41413
McHenry, H.I., *See* Reed, R.P., 2:41784
McHugh, J., Frigg onshore, 2:41043
McIlhinney, A.E., *See* Capes, C.E., 2:40739, 2:40740, 2:40904
McKay, H.A.C., Possible use of carboxylic acids for U/Pu separation in nuclear fuel reprocessing, 2:41090 (AERE-R—8509)
McKay, W., *See* Atkinson, D.W., 2:42211
Mckenney, D.B., Solar microclimatology. Final report, 2:41233 (N—76-28738)
McKinley, M.D., *See* Henry, J.F., 2:40854
McKinnon, J.A., S^3 solid state proton experiment. Part II. Mean energy of a finite energy passband. Technical memo, 2:41930 (PB—257833)
Mclain, A.G., Hybrid computer program for rapidly solving flowing or static chemical kinetic problems involving many chemical species, 2:41963 (N—76-29382)
McLaren, C., *See* Colonna, R.A., 2:41698
McLeary, R., *See* Whitcher, R.E., 2:41892
McMurrin, J.C., Performance measurements of a cylindrical glass honeycomb solar collector compared with predictions, 2:41229
McNally, J.H., Laser fusion and laser isotope separation overview, 2:42310
McNally, J.R. Jr., Advanced fuels for inertial confinement, 2:41152
McNeill, D.A., *See* Book, S.A., 2:42066, 2:42091, 2:42092
McPheeters, C.C., *See* Walsh, W.J., 2:41577
Meade, L.E., *See* Sturgeon, R.F., 2:41681, 2:41682
Meade, N.F., *See* Gates, J.M., 2:41283
Meadows, D.L., Critical post-1985 energy policy issues, 2:41584 (PB—255949)
Mecham, D.C., *See* Fujita, N., 2:41544
Meddens, B.J.H., *See* Hugenholtz, C.A.J., 2:42227
Mehrotra, A.K., *See* Misra, A.K., 2:41004
Mehta, S.K., Innovations in PHWR design, integration of nuclear power stations into power systems and role of small size nuclear power plants in a developing country, 2:41370 (IAEA-CN—36/394)
See Challappa, S., 2:41307
Meier, H.U., Investigation of acid-resistant electrocatalysts for fuel cells, 2:41664 (N—76-24724)
Mel'nikov, S.M., *See* Sycheva, A.M., 2:40944
Melent'ev, L.A., *See* Baturov, B.B., 2:41449
Mello, R.M., Simplified inelastic (plastic and creep) analysis of pipe elbows

subjected to inplane and out-of-plane bending, 2:41412
Men'shikova, T.S., *See* Zaimovskii, A.S., 2:41444
Menovsky, A., *See* Sechovsky, V., 2:41803
Mente, L.J., *See* Lee, W.N., 2:41943
Mercier, C., Neutrals and impurities in the Tokamak discharges, 2:42233 (AED-Conf—76-506-002)
Mergan, L.M., Evaluation of solidification matrices proposed for nuclear power plant radwaste, 2:41131 (IAEA-CN—36/186)
Meroney, R.N., Sites for wind power installations: wind tunnel simulation of the influence of two-dimensional ridges on wind speed and turbulence. Annual report, first year, 2:41245 (ERDA/NSF/00702—75/1)
Merrett, D.J., *See* Smith, D.R., 2:41514
Merrick, D., Energy savings by programmed heating of coke ovens, 2:40738
Merrill, W.H., *See* Soutar, P.S., 2:41057
Merritt, W.F., *See* Tomlinson, M., 2:41116
Merz, M.D., Internal stresses in α-plutonium during deformation, 2:41791
Mechanical properties of α-neptunium: hardness and elastic moduli, 2:41790
Sound velocity and elastic moduli in α-plutonium at pressures to 50 Kbar, 2:41789
Meshkov, A.G., *See* Kazachkovskii, O.D., 2:41398
Messer, K.P., *See* Spalthoff, F.J., 2:41111
Mewhinney, J.A., *See* Stanley, J.A., 2:42106
Meyer, J., *See* Spyrou, O., 2:42222
Meyer, K.T., Utilities for underground structures, 2:41590 (NSF-RA—760006, pp 165-181)
Meyer, M.B., Use of simulation in the design of a dial-a-ride system, 2:41709
Meyer, R., *See* Doggett, R.M., 2:41599
Miall, A.D., Sedimentary structures and paleocurrents in a tertiary deltaic succession, Northern Banks Basin, Arctic Canada, 2:40864
Michaels, S.L., *See* Michel, R.C., 2:41503
Michel, A., Introducing experimental evidence in critical aspects of SNR fuel design, 2:41403 (IAEA-CN—36/489)
Michel, F., *See* Maman, A., 2:41486
Michel, J., Simulation of silicon solar cells and comparison with experimental results, 2:41194 (N—76-29705)
Michel, R.C., Steady state heat transfer in ORR irradiation capsules. Part 2, 2:41503 (ORNL/MIT—232)
Micholas, D.J., Fast optics for the Rutherford laser compression experiments, 2:42307 (RL—76-147/B)
Miedema, A.R., Heat of formation of plutonium alloys, 2:41802
Mikhan, V.I., *See* Baturov, B.B., 2:41358
Mikhaylov, Yu.A., *See* Basov, N.G., 2:42221
Mikolowsky, W.T., Potential of liquid hydrogen as a military aircraft fuel, 2:41753 (AD-A—026666)
Mikulla, W., Experiences in using new steel types for high pressure gas lines constructing, 2:41044
Milam, T.B., Cylindrical polishing technology development program. Final report, 3 Jun 1974—31 Jul 1975, 2:41898 (AD-A—034680)
Milanese, M.M., *See* Bruzzone, H.A., 2:42238
Miles, J.H., *See* McKay, H.A.C., 2:41090
Miles, W.T., Simulation methods for nuclear production scheduling, 2:41446
Millar, W., *See* Atkinson, D.W., 2:42211
Miller, A., Neutron scattering by collagen, 2:42023 (BNL—50453, pp III.86-III.100)
Miller, A.G., Laser Raman spectrometric determination of oxy-anions in nuclear waste materials, 2:41868 (ARH-SA—279)
Miller, A.H., Boundary lubricity studies: structure—activity correlations in alkylpyridines, 2:41002
Miller, C.F., *See* Grier, W.F., 2:40879
Miller, E.L., *See* Hess, G.D., 2:41952
Miller, K.J., Flotation of pyrite from coal: pilot plant study, 2:40741
Miller, L.B., Study of radiation dosage to structural components in nuclear reactors. Final report, 2:41536 (PB—257567)
Miller, Yu.A., Electrometric method of finding spontaneous heating sites in coal, 2:40816
Millet, P., *See* Delpeyroux, P., 2:41394
Mills, M.T., *See* Werner, A.S., 2:40979
Mills, T.R., Erosion and sediment control audiovisual training program instructor's workbook. Final report, 2:41999 (PB—258471)
Mimura, M., Macroscopic oscillation and deformation of the plasma in SPICA, 2:42247 (Rijnhuizen—76-99)
Minear, R.A., Environmental aspects of coal production in the Appalachian Region. Progress report, June 1, 1976—May 31, 1977, 2:40871 (ORO—4946-2)
Minorsky, V.U., Ship collision study. Present situation survey. Final report, Jul 1974—Oct 1975, 2:41508 (PB—254750)
Minushkin, B., Heat transfer tests of an electrically heated 7-rod mock-up of an LMFBR radial blanket assembly, 2:41421
Miquel, *See* Levallet, E.H., 2:41393
Miquel, P., First experiments on the reprocessing of fast reactor fuels in France, 2:41092 (CEA-CONF—3683)
See Dolle, L., 2:41497
Mircea, A., *See* Michel, J., 2:41194
Mironov, V.M., *See* Sycheva, A.M., 2:40944
Misra, A.K., Complex esters as antiwear agents, 2:41004
Mitchell, N.T., Options for the disposal of high-level radioactive waste, 2:41136 (IAEA-CN—36/67)
Mitenkov, F.M., *See* Kazachkovskii, O.D., 2:41398
Mityaev, Yu.I., *See* Baturov, B.B., 2:41358
Miyahara, A., *See* Fujita, J., 2:42271
Miyajima, K., *See* Yagi, E., 2:41098
Miyamoto, K., *See* Hamada, Y., 2:42241
See Kajita, T., 2:42294
Miyanaga, I., Development of radioactive waste management at Japan Atomic Energy Research Institute, 2:41115 (IAEA-CN—36/156)
Miyanami, K., *See* Fan, L.T., 2:40797
Miyazu, T., Blending design using many kinds of coal and the evaluation system for single coal, 2:40734
Mizernyuk, G.N., Classification and systematization of possible combined engine schemes, 2:41746
Mizin, V.G., Estimation of the reducing properties of ferrocoke as a carbonaceous reducing agent in the smelting of ferroalloys, 2:40828
Mizuta, H., *See* Kikuchi, Y., 2:41527
Modelvskii, M.Sh., Petroleum and gas resources of foreign countries, 2:40916
Moers, J.C., Hybrid computer simulation of the dynamics of the Hoger Onderwijs Reactor, 2:41502 (IRI—131-76-01)
Mogard, H., Experimental investigations of the power ramp failure propensity of LWR fuel, 2:41520 (IAEA-CN—36/279)
Mohs, M.A., *See* Spedding, F.H., 2:41873
Moiseev, M.A., *See* Akhmedov, R.B., 2:41031
Moll, A.J., Economics of underground coal gasification, 2:40756 (MERC/SP—76/3, pp 169-178)
Molnar, L, *See* Barbur, I., 2:41301
Molokanov, Yu.K., *See* Pikalov, G.P., 2:40945
Molvig, K., *See* Basu, B., 2:42234
Molz, G., *See* Jueptner, G., 2:41324
Moment, R.L., Single-crystal elastic constants of a plutonium-gallium alloy, 2:41792
Mongillo, A.V., Battery wedge for submarines or other installations, 2:41574 (AD-D—003275)
Montalenti, P., Hermetic covers for European Ni/Cd cells, 2:41575 (N—76-27697)
Monteux, C., Device for saving fuel and cleaning off-gas in heating installations, 2:41282
Montgomery, C.R., *See* Ferrigno, D.P., 2:41348
Montoya, L.C., *See* Steers, L.L., 2:41741
Moon, L.C., Operation and maintenance of the Rare-Earth Information Center's Information Retrieval System (RICIRS) version 2, 2:42337 (IS—4104)
Moore, D.F., *See* Eastwood, D.E., 2:40760
Moore, P.B., *See* Engelman, D.M., 2:42026
Moore, T.D. Jr., Longwall gob degasification with surface ventilation boreholes above the lower Kittanning coalbed. Report of investigations, 2:40881 (PB—262189)
Moran, J., *See* Hunt, W.F. Jr, 2:41992
Moreau, C., Fabrication and irradiation performance of French HTGR fuel, 2:41084 (IAEA-CN—36/270)
Moreland, F.L., Alternative to suburbia, 2:41591 (NSF-RA—760006, pp 183-210)
Alternatives in energy conservation: the use of earth covered buildings, 2:41609 (NSF-RA—760006)
Morgan, J.R., *See* Hecker, S.S., 2:41788
Morgan, M.A., *See* Tesche, F.M., 2:41932
Mori, T., *See* Miyazu, T., 2:40734
Morimoto, S., Gas chromatographic analysis of air pollutants, 2:41985
Morison, W.G., Pickering generating station, 2:41375
Morozov, V.F., *See* Sycheva, A.M., 2:40944
Morris, C.W., *See* Szczuka, A.E., 2:40876, 2:40877
Morrison, G.W., *See* Pike, D.H., 2:41145
Morrison, J.A., *See* Tomlinson, M., 2:41116
Mosby, J.F., Pilot plant proves Resid process, 2:40958
Mostoller, M., *See* Smith, H.G., 2:41809
Mota, I., *See* De Macedo, M.S., 2:42082
Motojima, K., Iodine in oil and gas fields: especially on the geochemical consideration of the prospecting for iodine deposits, 2:42145 (N—76-27750)
Motriuk, T., Transport of coal by shuttle trains at Dymitrow colliery, 2:40886
Mougniot, J.C., *See* Levallet, E.H., 2:41393
Mould, R.W., Investigation of the activity of cutting oil additives. III. Oils containing both organochlorine and organosulphur compounds, 2:41026
Mousty, F., *See* Cecille, L., 2:41133
Muchinskii, Ya.D., *See* Polyakova, A.A., 2:40966
Muchnik, S.V., Feasibility of combined determination of the natural and residual methane content of a coal seam, the methane pressure in the seam, the sorption isotherms, and the gas emission kinetics, 2:40817
Muckelberg, E., Electrodynamic levitated train. Erlangen large-scale test plant is being converted to long stator technology, 2:41731
Muckenthaler, F.J., *See* Maerker, R.E., 2:41380

Muench, J., *See* Rossberg, L., 2:42192
Muench, R.A., Prediction of pump differential pressure for two-phase/two-component compressible flow, 2:41344
Muggli, F.M., *See* Holbrook, C.H., 2:42088
See Parks, N.J., 2:42064
Munn, S.L., *See* Wilson, F.D., 2:42081
Muraoka, S., *See* Gomay, Y., 2:42317
Murchison, D.G., *See* Goodarzi, F., 2:40837, 2:40839, 2:40840
Murgulescu, S., *See* Calusaru, A., 2:41081
Murley, T.E., Summary of LWR safety research in the USA, 2:41530 (IAEA-CN—36/584)
Murphy, M., *See* Lichtman, M.A., 2:42038
Murray, J.B., Changes in state of combination of inorganic constituents during carbonization of Victorian brown coal, 2:40737
Murray, R.C., *See* Tu, D.K., 2:41881
Murthy, G.S.K., *See* Challappa, S., 2:41307
Murthy, L.G.K., *See* Mehta, S.K., 2:41370
Musaev, I.K., *See* Akhmedov, R.B., 2:41031
Musso, B., *See* Mangiagalli, D., 2:41320
Muth, A., Eggs and hatchlings of captive Dipsosaurus dorsalis, 2:42069
Muto, T., Status of the development of mixed oxide fuels in PNC, 2:41489 (IAEA-CN—36/553)
Mutzl, J., *See* Jungmann, A., 2:41339
Myzin, A.L., *See* Arzamastsev, D.A., 2:41275

N

Naber, J.E., *See* Groenendaal, W., 2:40851
Nachtrieb, K., *See* Dietrich, I., 2:41884
Nadviga, G.S., *See* Ivanov, L.A., 2:41721
Naegele, J., Optical properties of UO_2 and U_4O_9 single crystals and their relation to chemical bonding, 2:41842
See Manes, L., 2:41829
Naill, R., *See* Meadows, D.L., 2:41584
Naito, K., *See* Inaba, H., 2:41852
Nakae, N., *See* Kirihara, T., 2:41858
Nakamura, H., *See* Gomay, Y., 2:42317
Nakamura, T., *See* Tezuka, S., 2:41256
Nakatani, R.E., *See* Palmisano, J.F., 2:41994
Nakatani, S., Characteristics of natural radioactivity appearing in its diurnal variation, 2:41988 (N—76-24799)
Nakayama, P. I., *See* Cook, J.L., 2:41381
Nakayama, P.I., *See* Cook, J.L., 2:41351
Nanda, V.P., *See* Bridges, J.E., 2:41934
Nandy, A.N., *See* Misra, A.K., 2:41004
Nannen, L.W., Investigation of the technical and economical feasibility of using low temperature geothermal sources in Colorado, 2:41237
Narkus-Kramer, M., *See* Doggett, R.M., 2:41599
Naruki, K., *See* Muto, T., 2:41489
Nasu, S., Electrical resistivity of uranium monophosphides, uranium mononitrides and uranium carbonitrides at low temperatures, 2:41843
See Kirihara, T., 2:41858
Natarajan, A., *See* Artman, J.O., 2:41823
See Challappa, S., 2:41307
Naumov, V.A., *See* Krasin, A.K., 2:41397
Nawrocki, M.A., *See* Mills, T.R., 2:41999
Naylor, V.D., Thermodynamic cycles and elemental efficiencies, 2:41261
Nazare, S., Properties of light water reactor core melts, 2:41555
See Dienst, W., 2:41822
Nechaev, L.V., Investigation of throughput capacity of a four-stroke diesel engine during the closing of valves, 2:41719
Nedoshivin, Yu.N., *See* Davydova, Zh.A., 2:40831
Neiman, V.S., *See* Berman, L.B., 2:41032
Neitzel, R.E., Study of turbofan engines designed for low enery consumption, 2:41743 (N—76-30218)
Nelson, D., *See* Lehr, J., 2:42136
Nelson, D.J., *See* Mann, B.J., 2:41141
Nemet, J., *See* Jungmann, A., 2:41339
Nesbitt, D., *See* Hargrove, J.L., 2:42068
Nesitka, A., *See* Jungmann, A., 2:41339
Nesterenko, V.B., Physical and technical aspects of nuclear and chemical safety of APS with fast reactors cooled with N_2O_4, 2:41521 (IAEA-CN—36/322)
See Krasin, A.K., 2:41397
Neuman, M.W., Metabolism of labeled parathyroid hormone. VII. Attempts to modify hormone deposition, 2:42054
Neuman, W.F., *See* Neuman, M.W., 2:42054
Neumann, J., *See* Barabas, K., 2:41451
Neumann, L., Correlation of composition, structure characteristics and properties for high level waste solidification products, 2:41134 (IAEA-CN—36/470)
Neuner, J.A., *See* Dufek, W.L., 2:41349
Neunert, B., *See* Jueptner, G., 2:41324
Neustadter, H.E., *See* Sidik, S.M., 2:41964
Newman, J., *See* Shifrine, M., 2:42039
Nicholson, E.W., *See* Cahn, R.P., 2:41273
Nihoul, P., *See* Cabanius, J., 2:41338
Nikiforov, A.S., *See* Dolgov, V.V., 2:41122
Nikipelov, B.V., *See* Dolgov, V.V., 2:41122
Nikolaev, A.I., *See* Averina, M.V., 2:40960
Nilan, R.A., *See* Sander, C., 2:42043
Nishida, S., Reactions of coal with nitrogen/hydrogen mixtures in a discharge, 2:40844
Reactions of coal with discharge-generated (excited) nitrogen species, 2:40845
Nishitani, S., *See* Tanaka, S., 2:42270
Nitsch, J., Production and utilization of alternative secondary energy carriers, 2:41158 (N—76-24726)
Noble, S.B., *See* Doggett, R.M., 2:41599
Noggle, L.W., *See* Mikolowsky, W.T., 2:41753
Nogueira, V., *See* Hurter, T., 2:41286
Nolan, M.E., *See* Dempsey, R.M., 2:40913
Nolen, R.L. Jr., Container for fusion fuel, 2:42304
Nomoto, K., *See* Taniguchi, K., 2:42073
Nomura, S., Active radicals containing oxygen and caking property of lignite, 2:40848
Present status of fuel researches for VHTR in Japan, 2:41357 (IAEA-CN—36/168)
See Gomay, Y., 2:42317
Nordstrom, B., Nuclear power plants: an alternative for large cities, 2:41443
Northrop, D.A., *See* Brandenburg, C.F., 2:40748
Northrup, C.J.M. Jr., Thermodynamics of the uranium (α,β and γ-phases)-hydrogen system, 2:41831
Norwitz, G., Determination of lithium stearate in sebacate-based lubricants by atomic absorption, 2:41006
Determination of diisopropyl phosphite in sebacate-base lubricants. Determination of phosphorus in diisopropyl phosphite, 2:41007
Spectrophotometric determination of antimony in sebacate-base lubricants by the iodide method, 2:41008
Nosovskii, V.I., *See* Borisov, A.V., 2:40925
Nougarede, F., *See* Despois, J., 2:41566
Novendstern, E.H., Outlet plenum flow stratification studies for the Clinch River Breeder Reactor Plant, 2:41422
Novikova, N.V., *See* Zil'berbrandt, A.M., 2:40800
Nowacki, P.J., Production of refined intermediate fuels with high temperature reactors, 2:41450 (IAEA-CN—36/376)
Nowik, I., *See* Gal, J., 2:41799
Nozaki, K., *See* Hasegawa, A., 2:42281
Nunes, A.C., *See* Kirschner, D.A., 2:42021
Nuttelman, R.A., Optimum design of an intensity limited pinhole-scintillator, image converter camera model for simultaneous energy, spatial, and time resolution of soft x-rays. Final report, 15 Aug 1975—30 Jun 1976, 2:42223 (AD-A—034405)
Nydick, S.E., Study of inplant electric power generation in the chemical, petroleum refining, and paper and pulp industries. Final report, 2:41247 (PB—255659)

O

O'Brien, E.J., *See* Worcester, D.L., 2:42024
O'Clair, C.E., *See* Palmisano, J.F., 2:41994
O'Shea, M.D., Melatonin action during hypobaric hypoxia, 2:42031
See Berkut, M.K., 2:42029
See Walmer, D.K., 2:42030
Oberle, R.D., *See* Duncan, D.A., 2:40794
Ocsai, M., *See* Szili, G., 2:41305
Ogren, J.A., Determination of the feasibility of ozone formation in power plant plumes. Volume I. Executive summary, 2:41978 (PB—262092)
Determination of the feasibility of ozone formation in power plant plumes. Volume II. Final report, 2:41979 (PB—262093)
Determination of the feasibility of ozone formation in power plant plumes. Volume III. Data summary, 2:41980 (PB—262094)
Determination of the feasibility of ozone formation in power plant plumes. Volume IV. Data summary, 2:41981 (PB—262095)
Determination of the feasibility of ozone formation in power plant plumes. Volume V. Data summary, 2:41982 (PB—262096)
Ohasa, K., Linked min.B configuration inside high shear magnetic surface, 2:42295 (N—76-25023)
See Hamada, Y., 2:42241
Ohse, R.W., Advances in vapour pressure studies over liquid uranium plutonium oxides up to 5000K, 2:41845
Evaporation behaviour of the ternary uranium plutonium carbides, 2:41846
Okrajni, S., Possibilities of biopolymer utilization for drilling fluids, 2:40934
Okuda, M., *See* Nasu, S., 2:41843
Okuyama, Y., *See* Miyazu, T., 2:40734
Ol'khovskii, G.G., *See* Bodrov, I.S., 2:41268
Olbjorn, E., *See* Valland, G., 2:40936
Olivier, J.P., Present trends in radioactive waste management policies in OECD countries and related international co-operative efforts, 2:41126 (IAEA-CN—36/491)
Olmos, J., Light-water reactor physics parameters for transient analysis. Final report 1 Jul 74—30 Jun 75, 2:41455 (PB—255169)
Olson, D.G., Determination of heavy elements in humans, 2:42099 (BNWL—2088, pp 81-84)
Olson, W.H., *See* Holmes, J.T., 2:41426
Omel'chenko, A.Ya., *See* Demchenko, V.V., 2:42259
Ondov, J.M., *See* Fisher, G.L., 2:41983
Ondracek, G., *See* Nazare, S., 2:41555
Onega, R.J., Nonlinear dynamics of a pressurized water reactor core, 2:41341

Onischa, Investigation of metal hydride materials as hydrogen reservoirs for metal—hydrogen batteries, 2:41162 (N—76-27667)
Oomens, A.A.M., *See* Mimura, M., 2:42247
Orlin, A.S., Prospects of development of internal combustion engines, 2:41712
Orlov, V.V., *See* Aleksandrov, I.V., 2:40830
Orme, J.T., Kinetics of the delta to alpha transformation in plutonium rich Pu-Ga alloys, 2:41774
Ormonde, S., New developments in lasers at wavelengths of 3000 A and below, 2:41911
Ortner, A.J., Proposed flight simulator technology program. Study project report, 2:41680 (AD-A—028888)
Ostashevskaya, N.S., *See* Filipchuk, I.G., 2:40822
Osterhout, M.M., *See* Holmes, J.T., 2:41426
Ostronov, B.C., *See* Averina, M.V., 2:40960
Otsuka, Y., *See* Irie, H., 2:41041
Ott, W.R., *See* Hunt, W.F. Jr, 2:41992
Otto, K.W., *See* Kietzer, K., 2:41528
Ouchi, K., Catalysts for the depolymerization of mature coals, 2:40842
Overton, D.E., *See* Minear, R.A., 2:40871
Owen, R.D., Studies in developmental immunogenetics. Annual progress report, 2:42062 (CALT—767P6-X11)
Owens, D.K., *See* Yamada, M., 2:42216
Oyama, A., *See* Suita, T., 2:41392
Oziraner, S.N., *See* Dolgov, V.V., 2:41122

P

Pachovsky, R.A., Effects of diffusion resistance on gasoline selectivity in catalytic cracking, 2:40954
Theoretical interpretation of gas oil selectivity data on x-sieve catalyst, 2:40956
See Best, D.A., 2:40955
Paessler, E.R., *See* Buurman, E., 2:41294
Pagano, M., *See* Tiede, J.J., 2:42059
Pages, M., Some actinides double orthovanadates and orthoarsenates: structural 'evolution' due to cationic and anionic substitutions, 2:41779
Paguta, M.T. *See* Ladikov, Yu.P., 2:42321
Pai, D.H., Inelastic analysis of tubesheets by the finite element method, 2:41363
Pakhomov, V.V., *See* Kazachkovskii, O.D., 2:41398
Palmadesso, P., *See* Basu, B., 2:42234
Palmer, H.E., Development of an improved counter for in vivo plutonium measurement, 2:42109 (BNWL—2088, pp 197-198)
In vivo plutonium measurement at the Battelle-Northwest whole body center, 2:42104 (BNWL—2088, pp 125-131)
Palmer, R.L., Mass-spectrometric measurements of enhanced methanation activity over cobalt and nickel foils. Interim report, 2:41170 (AD-A—034675)
Palmisano, J.F., Ecology of intertidal benches of Amchitka Island, Alaska. Final summary report, August 1, 1974—December 31, 1974, 2:41994 (RLO—2225-T36-1)
Pan, Y.S., Three-dimensional stress analyses of mitered elbows, 2:41473
Panasenkov, A., *See* Barbur, I., 2:41301
Pande, B.P., *See* Kondal Rao, N., 2:41086
Paoletti Gualandi, M., *See* Arcelli, G., 2:41331
See Mangiagalli, D., 2:41320
Papadopoulos, K., *See* Basu, B., 2:42234
Papp, G., Energy supply problems of process control computers in power plants, 2:41263
Papp, R., *See* Kessler, G., 2:41529
Parfenova, L.A., *See* Bogdanov, N.F., 2:40969
Park, H.S., *See* McKay, H.A.C., 2:41090
Parker, J.I., Concentration of diatom frustules in Lake Michigan sediment cores, 2:42005
Parker, R.J., Effect of lubricant extreme-pressure additives on rolling-element fatigue life, 2:41010
Parkinson, E.R., *See* Tesche, F.M., 2:41932
Parks, N.J., Canine bone dynamics, 2:42090 (UCD—472-123, pp 104-108)
Preliminary investigation of plasma sex hormone concentrations in normal and clinically abnormal male beagles, 2:42064 (UCD—472-123, pp 53-56)
Secondary aerosols from power plant effluents: delivery and in vivo detection systems, 2:42124 (UCD—472-123, pp 15-18)
Synthesis of ^{13}N- and ^{38}S-labeled fossil fuel power plant effluents for in vivo distribution studies, 2:42125 (UCD—472-123, pp 19-22)
Parks, P.B., *See* Christens, J.M.A., 2:41463
Parmley, W.W., Quantitation of ischemic and infarcted myocardium: relation between 99 Tc pyrophosphate and regional and total coronary blood flow, myocardial function and metabolism. Annual scientific report, 1 Jul 1975—31 Mar 1976, 2:42060 (PB—262160)
Parsons, B.I., *See* McColgan, E.C., 2:41059, 2:41060, 2:41062, 2:41063
See Soutar, P.S., 2:41057, 2:41061
See Takematsu, T., 2:41058
Parzen, G., Possible effects of lowering the periodicity in ISABELLE, 2:41925 (BNL—22237)
Pasha, M.L., *See* Farouq-Ali, S.M., 2:40763
Pashentsev, S.V., *See* Ivanov, L.A., 2:41721
Pashinin, P., Technology of inertial confinement systems. Report on the IAEA advisory group meeting on the technology of inertial confinement experiments, Dubna, Union of Soviet Socialist Republics, 19-23 July 1976, 2:42220
Pashkovskii, P.S., *See* Al'perovich, V.Ya., 2:40819
Pasini, J. III, *See* Shuck, L.Z., 2:40750
Paulus, P.B., Psychology of earth-covered buildings, 2:41585 (NSF-RA—760006, pp 65-69)
Pavone, G., About the proportioning of the water-flows for running water hydroelectric stations, 2:41178
Payne, J., Scintiphotos in the diagnosis of renal allograft malfunction, 2:42061
Payne, L.R., Hazards of cobalt, 2:42133
Peach, L.C., *See* Bridges, J.E., 2:41934
Pearl, W.L., *See* Sawochka, S.G., 2:41345
Pearson, R.L., Uranium loss from BISO-coated weak-acid-resin HTGR fuel, 2:41361 (ORNL/TM—5552)
Pease, L., Safety of heavy-water reactors, 2:41518 (IAEA-CN—36/181)
Peduzzi, A., *See* Roberts, R., 2:41750
Peek, N., *See* Parks, N.J., 2:42125
Pegg, W.J., Physiological effects of sublethal levels of acid water on fish, 2:42122 (PB—253958)
Pegoraro, F., *See* Basu, B., 2:42234
Pekal'n, T.K., *See* Averina, M.V., 2:40960
Pellegrin, M.T., Real mass and energy transport coefficients determined from UCG process simulation experiments, 2:40786 (MERC/SP—76/3, pp 526-540)
Penet, F., *See* Bailly, J., 2:41519
Perret, J., Contribution to the study of initiation and propagation mechanisms of treeing in polyethylene for high voltage cables, 2:41293
Persson, B., *See* Mandahl, B., 2:41121
Peschke, E.F., 380 kV single-core oil-filled cables and fittings, 2:41295
Peters, W.A., *See* Bush, T.W., 2:40743
Petersen, F.R., *See* Wells, J.S., 2:41906
Petersen, K., *See* Kietzer, K., 2:41528
Peterson, R.E., Improvement of black nickel coatings. Final report, 2:41226 (N—76-28404)
Petit, G.S., Accelerated test for filter media exposure to fluoride environment, 2:41887 (K/TL—644)
Scanning electron microscope examination of samples from Herty Foundation in development of fluoride-resistant HEPA filter media, 2:41886 (K/TL—639)
Petrov, Al.A., *See* Gulyaeva, N.D., 2:40832
Petryanov, I.V., *See* Galkin, B.Ya., 2:41132
Petukhov, V.N., *See* Popova, L.A., 2:40823
Pham, H.T., *See* Sawochka, S.G., 2:41345
Phemister, R.D., *See* Chrisp, C.E., 2:42079
Phillion, D.W., *See* Ahlstrom, H.G., 2:42308
Phillips, B.A., *See* Browning, P., 2:41839
Phillips, J.A., *See* Burkhardt, L.C., 2:42299
Phillips, J.D., Assessment of a single family residence solar heating system in a suburban development setting. Monthly report, 2:41212 (PB—254493)
Assessment of a single family residence solar heating system in a suburban development setting. Monthly report, 2:41213 (PB—254494)
Assessment of a single family residence solar heating system in a suburban development setting. Monthly report, 2:41214 (PB—254495)
Assessment of a single family residence solar heating system in a suburban development setting. Monthly report, 2:41215 (PB—254502)
Assessment of a single family residence solar heating system in a suburban development setting. Monthly report, 10 Aug—10 Sep 1975, 2:41216 (PB—255049)
Pickman, D.O., SGHWR fuel performance, safety and reliability, 2:41366 (IAEA-CN—36/63)
Pikalov, G.P., Analysis of operation of topping tower in high-capacity unit for crude oil distillation, 2:40945
Pike, D.H., New approach to safeguards accounting, 2:41145 (ORNL/CSD/TM—25)
Pillsticker, M., Results of experiments with a superconductive prototype coil for a toroidal magnet, 2:42300
Pimenov, M.K., *See* Spitsyn, V.I., 2:41139
Pinegre, M., Photo-excitation and photo-ionization ahead of a strong shock wave in argon, 2:42232
Pireaux, J.J., *See* Verbist, J.J., 2:41850
Pistella, F., *See* Arcelli, G., 2:41331
See Mangiagalli, D., 2:41320
Platt, A.M., *See* Culler, F.L. Jr., 2:41112
Platter, D.W., *See* Hartstein, A.M., 2:40836
Plesser, N., Gas industry development in Federal Republic of Germany in 1975, 2:41036
Plewa, M.J., Monosomic analysis of fatty acid composition in embryo lipids of Zea mays L, 2:42033
Plotkin, E.R., Some features of organization of starting conditions of the 300 MW monoblock, 2:41258
Plotnikov, V.P., Comparative analysis of cutter and drill splitting mechanisms of mining machines, 2:40882
Pobedonostseva, N.I., *See* Zabramnyi, D.T., 2:40808
Pobedonostseva, O.I., *See* Zabramnyi, D.T., 2:40808
Poboiskii, O.E., *See* Primenko, V.I., 2:40962
Pobul, L.Ya., Investigation of the group and component composition of the

alcohol-benzene extract of the combustible shale of the boltysh deposit of the Ukrainian SSR, 2:41065
Pochelon, A., The m = 1 motion of a screw pinch measured by external magnetic probes, 2:42245 (N—76-31015)
Pogal, M., *See* Lichtman, M.A., 2:42038
Pohlenz, J.B., *See* Groenendaal, W., 2:40851
Polishchuk, V.L., *See* Siryi, P.O., 2:41267
Polyakova, A.A., Molecular structure of pyrolysis coke, 2:40966
Polyakova, M.M., *See* Tesner, P.A., 2:41168
Ponder, T.C. Jr, Simplified procedures for estimating flue gas desulfurization system costs. Final report May 74—Apr 76, 2:41278 (PB—255978)
Ponomarev-Stepnoj, N.N., *See* Aleksandrov, A.P., 2:41438
Pool, R.R., *See* Chrisp, C.E., 2:42089
Popa, G., *See* Sato, N., 2:42267
Popolato, A., *See* Randolph, A.D., 2:41942
Popov, A.F., *See* Demirkhanov, R.A., 2:42256
Popova, L.A., Investigation of the floatability of coals of different ranks by measuring the heat effects of wetting, 2:40823
Porta, A., *See* Doniat, D., 2:41569
Porter, C.H., *See* Vitberg, A.K., 2:41696
Posehn, M.R., *See* Fisher, D.K., 2:41938
Postle, W., Investigation into the computerized data bases of the Employment and Training Administration. Regional Management Information System Project (RMIS) report on second-year activities, 1975—1976, 2:42338 (LBL—6122)
Posyl'nyi, V.Ya., Anisotropy of anthracites from the results of a study of microhardness, 2:40825
Potter, P.E., Some phase relationships and equilibria for the uranium-plutonium monocarbonitrides including the effects of oxygen on some equilibria, 2:41833
See Browning, P., 2:41839
See Haines, H.R., 2:41827
Pouzo, J.O., *See* Bruzzone, H.A., 2:42238
Povolotskiy, L.V., *See* Kapinos, V.M., 2:41918
Powell, B.W., *See* Fries, R.J., 2:41149
Powell, R.L., *See* Wier, C.E., 2:40869
Poznyak, V.J., *See* Alikaev, V.V., 2:42214
Prachuktam, S., *See* Chang, T.Y., 2:41465
Pradel, J., *See* Candes, P., 2:41120
Prater, R., Doublet fusion programme - one step from electricity production, 2:42284
Pravdo, S.H., *See* Becker, R.H., 2:42157
Prentice, B.A., *See* Fisher, G.L., 2:41983, 2:42120
See McFarland, A.R., 2:42119
Prepejchal, W., *See* Romberg, G.P., 2:41937
Price, A.R., Bacillus subtilis deoxyuridinetriphosphatase and its bacteriophage PBS2-induced inhibitor, 2:42055
Price, F.A., *See* Smith, R.A., 2:41545
Price, W.E., *See* Stanley, A.G., 2:41935
Prilepskaya, L.L., *See* Mizin, V.G., 2:40828
Prilutskiy, O.F., Powerful bursts of cosmic gamma radiation, 2:42161 (N—76-29149)
Primenko, V.I., Influence of dissolved water on static electrification of jet fuels, 2:40962
Prince, R.A., *See* Heath, G.R., 2:41135
Profos, D., *See* Bock, H.W., 2:41490
Pronicheva, M.V., Paleogeomorphological preconditions of discovery of petroleum and gas-bearing zones in the Jurassic and Triassic complexes of Northern Emba, 2:40923
Proskulryakov, V.A., Pilot plant for producing a mixture of crude dicarboxylic acids from shale, 2:41067 (PB—254581-T/SL)
Proskuryakov, V.A., *See* Lopachenok, L.V., 2:41066
Protnikova, N.P., *See* Babkin, R.L., 2:40909
Protsenko, A.N., *See* Aleksandrov, A.P., 2:41438
Provkina, R.G., *See* Sabadash, Yu.S., 2:40980
Prutkovskii, E.N., *See* Markov, N.M., 2:41257
Pszystawa, J., Magnetic phase transitions in UO_2 and uranium compounds with crystal structures of Th_3P_4-type, 2:41780
Puddington, I.E., *See* Capes, C.E., 2:40739, 2:40740
Pulpan, H., Alaska Peninsula telemetered seismic network. Annual report, 2:42141 (RLO—2229-TC-3)
Purington, R.G., Friction loss studies using a 0.0127-m fire hose, 2:41921
Pushlo, V.N., *See* Kondrashin, A.V., 2:41271
Pustovalov, V.V., Plasma nonstationary turbulence while parametric resonance, 2:42257
Pyatkov, V.P., *See* Nechaev, L.V., 2:41719

Q

Qader, S.A., Hydrocracking of polynuclear aromatic hydrocarbons over silica-alumina based dual functional catalysts, 2:40953
Quinn, W.E., *See* Krakowski, R.A., 2:42283

R

Raabe, O.G., *See* Parks, N.J., 2:42124
Rabinovich, I.S., *See* Polyakova, A.A., 2:40966
Rabl, A., *See* Allen, J., 2:41231
Radloff, R.J., *See* Gupta, P., 2:42045
Radmer, R.J., *See* Kok, B., 2:41198
Ragaini, R.C., *See* Fisher, G.L., 2:41983
Rairden, J.R., Coatings for directional eutectics. Final report, 2:41814 (N—76-29370)
Rajendran, R., *See* Kondal Rao, N., 2:41086
Rakov, N.A., *See* Blinov, V.A., 2:41140
See Spitsyn, V.I., 2:41139
Rakovskii, V.E., *See* Karaseva, E.Z., 2:40818
Ramos Salvador, L., *See* Lopez Perez, B., 2:41118
Ranc, R., *See* Moreau, C., 2:41084
Rand, M.H., *See* Browning, P., 2:41839
Randl, R.P., Waste management in the Federal Republic of Germany: a survey of policy and research and development, 2:41114 (IAEA-CN—36/98)
Randolph, A.D., Rapid heating-to-ignition of high explosives. I. Friction heating, 2:41942
Rao, C.S.R., *See* Mclain, A.G., 2:41963
Rappeport, M., Conservation of energy in the home. Highlight report, Volume XVII. Monthly report, 2:41623 (PB—254628)
Public attitudes and behavior regarding energy conservation: detailed tabulations by U.S. population and population segments. Waves 5 and 6, 2:41617 (PB—254304)
Public attitudes and behavior regarding energy conservation: detailed tabulations by U.S. population and population segments. Waves 20 and 21, 2:41618 (PB—254305)
Public attitudes and behavior regarding energy conservation: detailed tabulations by U.S. population segments; Waves 26 and 27. Monthly tabulated report, 2:41619 (PB—254588)
Public attitudes and behavior regarding energy conservation: detailed tabulations by U.S. population segments; Waves 22 and 23, 2:41620 (PB—254589)
Public attitudes and behavior regarding energy conservation: detailed tabulations by U.S. population segments; Waves 7 and 8. Monthly tabulated report, 2:41621 (PB—254590)
Public attitudes and behavior regarding energy conservation: detailed tabulations by U.S. population segments; Waves 3 and 4. Monthly tabulated report, 2:41622 (PB—254591)
Public attitudes and behavior regarding energy conservation: Detailed tabulations by U.S. population and population segments, Waves 1 and 2, 2:41625 (PB—255003)
Rard, J.A., Isopiestic determination of the activity coefficients of some aqueous rare earth electrolyte solutions at 25°C. II. The rare earth perchlorates, 2:41874
Review of osmotic coefficients of aqueous $CaCl_2$ at 25°C, 2:41877
Rastogi, B.P., *See* Kati, S.L., 2:41522
Rastorguev, Yu.L., Experimental investigation of heat capacity of Samotlor crude oil and cuts from this crude, 2:40965
See Bogatov, G.F., 2:40999
Rasumova, K.A., *See* Alikaev, V.V., 2:42214
Rau, B.R., "Almost-exact" solution to the N-processor, M-memory bandwidth problem. Technical report No. 117, 2:42333 (SU-SEL—76-025)
Raub, J., *See* Parks, N.J., 2:42124
Rauh, R.D., Effect of additives on lithium cycling in propylene carbonate, 2:41579
Effect of additives on lithium cycling in methyl acetate, 2:41580
Ray, A.K., *See* Kati, S.L., 2:41522
Ray, J.A., *See* Barnett, C.F., 2:42231
Ray, R.N., *See* Mehta, S.K., 2:41370
Raymond, A.J., *See* Camin, D.L., 2:41024
Razgaitis, R.A., *See* Holman, J.P., 2:41175
Razhev, A.M., *See* Ishchenko, V.N., 2:41915
Rea, S.N., Large area Czochralski silicon. Quarterly report No. 3, 2:41184 (ERDA/JPL/954475—76/3)
Recoupe, P., *See* Perret, J., 2:41293
Rediker, R.H., Optics research, 1976:1. Semiannual technical summary report, 1 Jan—30 Jun 1976, 2:41896 (AD-A—034583)
Redon, A., Management of high level radioactive waste, 2:41119 (IAEA-CN—36/226)
Reed, K., *See* Allen, J., 2:41231
Reed, R.P., Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB—261996)
See Beard, S.G., 2:40769
Rees, D.M., Pneumatic classification of slack coal, 2:40903
Reese, C., *See* Hamburg, A., 2:42041
Rehder, R., Method for transporting liquefied natural gas, 2:41048
Reich, M., *See* Chang, T.Y., 2:41465

Reichle, L.F.C., MSR (Pu converters) and MSBRs in commercial nuclear power stations, 2:41400 (IAEA-CN—36/424)
Reidick, H., Recent design concepts for coal firing, 2:41923
Reif, A.E., Sufficient absorption: a quantitative method to replace exhaustive absorption, 2:42051
Reinemann, K., *See* Kreher, K., 2:41561
Reisacher, J., Bearing application of quick running rotors, particularly of waste gas superchargers, 2:41882
Reiser, C.O., *See* Holland, W.D., 2:41099
Reister, D.B., Energy embodied in goods, 2:41654 (ORAU/IEA(M)—77-6)
See Barkenbus, J.N., 2:41604
Reiter, R.F., Rocket-borne time-of-flight mass spectrometry, 2:42184 (N—76-28723)
Rello, R.M., Nuclear off-gas treatment...the cryogenic distillation method, 2:41323
Renard, F.M., Threshold effects in annihilation processes, 2:42196 (N—76-27996)
Renieri, G.D., Nonlinear analysis of laminated fibrous composites, 2:41861 (N—76-27359)
Renner, E., Hybrid-engine, 2:41734
Renner, R.A., *See* Luchter, S., 2:41726
Rensel, W.B., *See* Henderson, T.M., 2:41151, 2:41153
Reshetnikov, F.G., Technological aspects of fuel manufacture for different power reactors, 2:41085 (IAEA-CN—36/352)
Rethier, M.A., *See* McColgan, E.C., 2:41063
Reynolds, B., *See* Schmid, F., 2:41181
Reynolds, R.G., *See* Anand, R.K., 2:41417
Rhodes, C.G., *See* Berryman, R.G., 2:41756
Ribe, F.L., *See* Krakowski, R.A., 2:42283
Ricci, E., *See* Barnett, C.F., 2:42231
Rice, D.A., *See* Keller, D.V., 2:41926
Rice, R.L., *See* Berber, J.S., 2:40812
Richter, E., Waldeck II underground pumped-storage station, 2:41559
Waldeck II underground pumped-storage station, 2:41563
Rickard, C.L., Gas-cooled fast reactor safety, 2:41513 (IAEA-CN—36/36)
Rider, M.A., *See* Meroney, R.N., 2:41245
Ridley, B.W., *See* Chang, H.H., 2:42202
Riedler, W., *See* Rossberg, L., 2:42192
Rieksts, G.A., *See* Palmer, H.E., 2:42104
Riga, J., *See* Verbist, J.J., 2:41850
Rinaldini, C., *See* Charrault, J.C., 2:41304
Ripin, B.H., *See* Manheimer, W.M., 2:42305
Roake, W.E., Safety considerations in fast reactor fuel development, 2:41512 (IAEA-CN—36/18)
Roark, A.L., Risk analysis and transportation planning, 2:41704
Robbins, J.D., Criteria for developing pollution abatement programs for inactive and abandoned mine sites, 2:41998 (PB—258279)
Robbins, J.L., *See* Alexander, C.A., 2:41838
See Kruger, O.L., 2:41800
See Thayer, W.L., 2:41806
Roberts, G., *See* Brennan, J.K., 2:42053
Roberts, G.A.H., Microbiological corrosion of tanks in long-term storage of gas oil, 2:41028
Microbiological corrosion of tanks in long-term storage of gas oil. II. Further bacterial studies and use of borax as a biocide, 2:41029
Roberts, J.T.A., *See* Wrona, B.J., 2:41556
Roberts, M., Conclusions from the Oak Ridge EPR studies and initiation of the TNS program. A brief summary, 2:42278 (ORNL—5278)
Roberts, R., Experimental clean combustor program, Phase 2, 2:41750 (N—76-28429)
Roberts, R.W., Status and program of development of the fast breeder reactor system in the U.S., 2:41401 (IAEA-CN—36/427)
Robin, J., *See* Levallet, E.H., 2:41393
Robinson, A.C., Kinetics of the βyieldsα transformation in unalloyed plutonium after partial formation of the β phase, 2:41775
Robinson, C.M., *See* Reif, A.E., 2:42051
Robinson, L.C., *See* Bartlett, D.V., 2:42228
Rodyushkin, G.K., *See* Saprykin, G.S., 2:41272
Roenisch, J., Controlled heat from the floor. Electric floor heating accumulates heat in the concrete floor, 2:41672
Roessler, W.U., *See* Iura, T., 2:41711
Rogailin, M.I., *See* Zil'berbrandt, A.M., 2:40800
Rohatgi, H.S., *See* Agrawal, B.B., 2:41017
Rohr, D.L., Fracture behavior of a Pt—30% Rh—8% W alloy between room temperature and 1300°c, 2:41156
Rollason, P.H., *See* Hallett, J.L., 2:41570
Rolstad, E., Fuel reliability in light water reactors, experience and assessment for the future, 2:41316 (IAEA-CN—36/474)
Roman, W.C., Plasma core reactor simulations using RF uranium seeded argon discharges, 2:41454 (N—76-30046)
Romanczyk, E., Possibility of cleaning Polish coal fines by oil flocculation, 2:40902
Romanov, A.N., *See* Chertkov, Ya.B., 2:40963, 2:40967
Romanyuk, L.I., 'Enlightement' of a wave barrier under conditions of parametric instability of a pre-barrier plasma, 2:42261
Romashkin, B.G., *See* Bakumenko, O.D., 2:41396
Romberg, G.P., Thermolumiminescent dosimeters (TLD's) used to monitor temperature exposure, 2:41937 (CONF-770201—2)
Romick, G.J., Report on the geophysical description and available data associated with rocket PF-SH-92 (IC 519.07-1B), 2:42178 (AD-A—034381)
Report on the geophysical description and available data associated with rocket PF-NH-89 (IC 507.11-2a), 2:42189 (AD-A—034731)
Rosenberg, D.G., Assessment of hazardous waste practices in the petroleum refining industry. Final report, 2:40990 (PB—259097)
Rosenblatt, L., *See* Chrisp, C.E., 2:42089
Rosenblatt, L.S., *See* Chrisp, C.E., 2:42079
Rosenbluth, M.N., *See* Chen, L., 2:42246
See Cohen, B.I., 2:42250
Rosenfield, D., *See* Bodin, L., 2:41703
Ross, R.H., *See* Harnden, D.S., 2:42117
Rossberg, L., Multisatellite study of auroral zone phenomena. Part 2: observations during a substorm period on 11 November 1969, 2:42192 (N—76-27758)
Rossinskii, V.M., *See* Malyavinskii, L.V., 2:41723
Rothschild, R.E., *See* Becker, R.H., 2:42157
Rouse, C.A., Gas-cooled fast breeder reactor shielding benchmark calculation, 2:41383 (GA-A—14236)
Rousseau, J., Development of a solar-powered residential air conditioner: system optimization preliminary specification, 2:41210 (N—76-30660)
See Delpeyroux, P., 2:41394
Rouyer, H., Pulse columns: advantages and selection criteria, 2:41091 (CEA-CONF—3615)
Rowe, W.G.E., Waste heat utilisation by 'co-operative' group schemes, 2:41689
Rozenblit, G.B., Evaluation of radiant heat exchange in the cylinders of internal combustion engines, 2:41713
Rozental, I.L., *See* Prilutskiy, O.F., 2:42161
Rozhdestvenskii, V.V., *See* Vlasenkov, V.S., 2:42288
Rozsa, R., Lawrence Livermore Laboratory coal gasification program: underground reaction modeling and laboratory combustion-tube experiments, 2:40777 (MERC/SP—76/3, pp 422-429)
Rubel, P., Human factors in CRBRP design and planning for safety, 2:41406 (ORNL/TM—5681)
Rucker, M.L., *See* Vitberg, A.K., 2:41696
Rudkovskii, A.D., *See* Pikalov, G.P., 2:40945
Rule, J.H., *See* Minear, R.A., 2:40871
Rundberg, R., Neutron absorption cross section of sodium 22, 2:42201
Rundo, J., Methods for the assay of plutonium in vivo: what are the alternatives, 2:42108 (BNWL—2088, pp 179-196)
Rupert, V.C., *See* Ahlstrom, H.G., 2:42308
Rupinskas, R.L., Thin-film evaporators for processing BWR liquid radwaste, 2:41325
Rupp, O., Hydraulic heat engine, 2:41728
Ruppik, H., Combustion driven cw high power lasers, 2:41903 (N—76-24562)
Ruskov, S., *See* Kostadinov, K., 2:41332
Russell, D.S., *See* Capes, C.E., 2:40904
Russell, O.R., *See* Wier, C.E., 2:40869
Russell, R.A., Non-ideal liquid activity coefficients, 2:40959
Russell, S.H., *See* Foster, J.S., 2:41367
Rustagi, R.S., *See* Kati, S.L., 2:41522
Rutherford, P.H., *See* Chen, L., 2:42246
Rutter, R.L., *See* Edney, C.J., 2:41107
Ruzmaykina, T.V., *See* Burdyuzha, V.V., 2:42162
Ryan, T.C., *See* Guter, G.A., 2:42016
Rybina, L.P., *See* Aerov, M.E., 2:40943
Rybnicek, J., *See* Kafka, F., 2:41471
Rychlewski, T.V., *See* Hallett, J.L., 2:41570
Rychlicki, S., *See* Twardowski, K., 2:40924

S

Sabadash, Yu.S., Thermal stability of sulfur compounds in heavy petroleum residual stocks, 2:40980
Sabounqi, M.L., Theoretical concepts useful in the calculation or storage of phase diagrams of ionic systems, 2:41863 (CONF-770116—1)
Sadovskii, B.F., *See* Galkin, B.Ya., 2:41132
Saff, E.B., Angular overconvergence for rational functions converging geometrically on (0, + infinity), 2:42336
Sage, W.L., *See* Downs, W., 2:40900
Sahni, D.C., *See* Kati, S.L., 2:41522
Saibil, H., *See* Chabre, M., 2:42022
Saint-Hilaire, G., *See* Drouet, M.G., 2:42244
Saito, R., *See* Yoshida, Y., 2:42293
Saito, S., *See* Yagi, E., 2:41097
Sakai, T., Study of NaK flow and heat transfer, (1). Tabulation of the physical quantities of NaK, 2:41796 (PNC-N—941-75-113)
Sakata, S., *See* Miyanaga, I., 2:41115
Sako, K., *See* Yamato, H., 2:42276
Sakurai, T., Fluorination of uranium compounds by gaseous bromine trifluoride and a bromine-fluorine mixture, 2:41077 (JAERI—1243)
Salter, S.H., Wave power nodding duck wave energy extractors, 2:41242
Samans, C., *See* Gutzeit, J., 2:40952
Samchuk, G.I., *See* Polyakova, A.A., 2:40966

Sampathkumar, R., *See* Chaudhuri, N.K., 2:41866
Sanada, Y., Formation of anisotropic mesophase from various carbonaceous materials in early stages of carbonization, 2:40736
Sandborn, V.A., *See* Meroney, R.N., 2:41245
Sandenshaw, T.A., Anomalous thermal property behaviour of uranium at low temperatures, 2:41793
Sander, C., Increasing the efficiency of azide mutagenesis in barley, 2:42043 (RLO—2221-T2-31)
Sandifer, C.W., Measurement of scintillation decay times for NE-111 and NE-102 fluors, 2:41927 (EGG—1183-2331)
Sanford, B., *See* Tomlinson, M., 2:41116
Sanford, P., *See* Andresen, R.D., 2:41928
Sanin, P.I., Investigation of anti-wear additives under various loads and at different sliding speeds, 2:41003
Sanmartin, J.R., Influence of laser design parameters on the hydrodynamics of microfusion plasmas, 2:42306 (JEN—351)
Sannikov, V.V., *See* Alikaev, V.V., 2:42214
Sano, E., *See* Colonna, R.A., 2:41698
Santarova, M., *See* Neumann, L., 2:41134
Santner, J.F., *See* Kawahara, F.K., 2:40994
Saprykin, G.S., Some specific features of the calculation of the reliability indices of peak gas turbine power plants, 2:41272
Sarapuu, E., Fundamental aspects of in situ electrocarbonization and electrogasification of coal, 2:40787 (MERC/SP—76/3, pp 541-552)
Saris, C., *See* Dasgupta, R., 2:42032
Sarma, M.S.R., *See* Iyengar, P.K., 2:41306
Sasakura, K., *See* Shimazu, H., 2:41548
Sasser, L.B., *See* Kelman, B.J., 2:42058
Sato, I.M., *See* Imakuma, K., 2:41088
Sato, M., *See* Taniguchi, K., 2:42073
Sato, N., Non-linear mixing of dispersive waves, 2:42267
Saunders, G.W., Decomposition in freshwater, 2:42004
Sauter, G.D., Will the large-scale production of hydrogen be part of the energy problem or part of its solution, 2:41161
Savin, N.I., *See* Kazachkovskii, O.D., 2:41398
Savvinova, G.N., *See* Pronicheva, M.V., 2:40923
Sawochka, S.G., PWR secondary system chemistry during air and cooling water in leakage, 2:41345
Sawtelle, G.R., *See* Fujita, N., 2:41544
Sawyer, W.K., Review of current UCG model capabilities, 2:40782 (MERC/SP—76/3, pp 477-488)
Schaal, M., *See* Adar, J., 2:41447
Schafstall, H.G., *See* Schroeder, E., 2:41507
Scheller, J.D., *See* Mello, R.M., 2:41412
Schemel, R., Operational problems in gas piping system following conversion to natural gas, 2:41045
Schenck, W., Offshore platform, 2:41890
Schenk, H., *See* Stehle, H., 2:41318
Schertz, W., *See* Allen, J., 2:41231
Schilg, G., Considerations on the use of N_2O_4 as a cooling and working medium in nuclear power plants with fast breeder reactors, 2:41411
See Altmann, W., 2:41249
Schlain, D., Electrodeposition of titanium diboride coatings. Report of investigations 1976, 2:41816 (PB—257 384)
Schmid, F., Heat exchanger-ingot casting/slicing process. Silicon sheet growth development for the large area silicon sheet task of the low cost silicon solar array project. Fifth quarterly progress report, September 25, 1976—December 16, 1976, 2:41181 (ERDA/JPL/954373—76/5)
Schmidt, B., Subsurface exploration methods for soft ground rapid transit tunnels. Volume II: Appendixes A-F. Final report Jun 73—Jun 75, 2:41740 (PB—258344)
Schmidt, D.K., Effective boiler feed control for test loops, 2:41424
Schmidt, E., *See* Cecille, L., 2:41133
Schmidt, G., Environmental impact of open pit mining in the conclusions of 'bergbau '76', 2:40863
Schmidt, K.D., *See* Todd, D.K., 2:42010
Schmitter, K.H., Dynamic constraints on inductive energy storage, 2:42298
Schmitz, F., Electrical conductivity of (U,Pu) Osub(2+-x) in the pure state and with addition of molybdenum, 2:41847
Schnakenberg, G., *See* Dempsey, R.M., 2:40913
Schneidmiller, D., *See* Larrick, A.P., 2:41104
Schoenborn, B.P., *See* Blasie, J.K., 2:42020
See Engelman, D.M., 2:42026
See Kirschner, D.A., 2:42021
Schofield, A.E., *See* Burkhardt, L.C., 2:42299
Schols, R.S., *See* van Domselaar, H.R., 2:40939
Schorr, J.R., Source assessment: glass container manufacturing plants. Final report, Sep 1975—Sep 1976, 2:41977 (PB—262002)
Schraewer, R., Production and transport of hydrogen slush. Final report, 2:41163 (N—76-24421)
Schram, D.C., *See* Lambert, A.J.D., 2:42262
Schrider, L.A., *See* Brandenburg, C.F., 2:40748
Schroeder, E., Nuclear merchant ship propulsion, 2:41507 (IAEA-CN—36/93)
Schroeder, G., *See* Eichmann, D., 2:41296
Schuermeyer, G., Oil and gas from the North Sea. I, 2:40929
Schuetzenduebel, W.G., Feedwater chemistry requirements for HTGR steam generator operation, 2:41365
Schuetzle, R., *See* Beck, W., 2:41531
Schultz, G., Study of a particle detector with very high spatial precision (drift chambers), and analysis of the physical phenomena governing the operation of this detector, 2:41931 (CRN-HE—76-15)
Schulz, B., *See* Nazare, S., 2:41555
Schulz, R.J., An investigation of ducted, two-stream, variable-density, turbulent jet mixing with recirculation. Final report, 23 May 1975—30 Jun 1976, 2:41922 (AD-A—034537)
Schulze-Trautmann, H., Energy savings in propylene/propane splitting, 2:40973
Schwabe, J.E., *See* Van Der Sluys, W.A., 2:41783
Schwartz, F.W., Radioactive waste management: model analysis of a proposed site, 2:41129
Schweizer, T.C., *See* Thornton, S.T., 2:42205
Scott, J.C., *See* Lundahl, C.R., 2:41205
Scott, R.L., Inactive and abandoned underground mines. Water pollution prevention and control, 2:42011 (PB—258263)
Scott, W.H. Jr., FLAIR: a scaling and folding code for the generation of photon transport results in air. Final report, 2:42208 (AD-A—034754)
Seavey, R.W., *See* Beckham, L.W., 2:40759
Sechovsky, V., Investigation of some magnetic and electric properties of compounds in the U-Ga system and of the U_3As_4 compound, 2:41803
Sedlet, J., *See* Golchert, N.W., 2:41961
Sedov, V.M., *See* Dolgov, V.V., 2:41122
Seeberger, J.F., Generalized theory for diffusive fluid flow through solid, permeable media, 2:40783 (MERC/SP—76/3, pp 489-506)
Seeger, H., Power supply system, particularly for the supply of auxiliary devices of a passenger cars with energy from the electric contact line, 2:41730
Seeley, R.R., *See* Van Der Sluys, W.A., 2:41783
Seidl, O., *See* Jueptner, G., 2:41324
Seipel, H.G., LWR safety research in the Federal Republic of Germany, 2:41525 (IAEA-CN—36/541)
Seki, S., *See* Yoshida, Y., 2:42293
Seki, Y., *See* Ide, T., 2:42286
See Maekawa, H., 2:42287
Seleznev, Yu.V., Thermophysical analysis of gas-phase processes developing in space and time in diesel units, 2:41720
Seltzer, S.M., *See* Trombka, J.I., 2:42149
Semenko, M.G., *See* Fridman, G.E., 2:40810
Semenovker, I.E., Thermal and temperature regimes of the experimental membrane waterwall of the PK-41 steam generator, 2:41270
Sentell, R.J., *See* Singh, J.J., 2:40986
Serebryakov, O.I., Phase state of hydrocarbons of the Caspian Depression, 2:40919
Serebryakov, V.A., *See* Dobrynin, V.M., 2:40926
Seregin, E.P., *See* Chertkov, Ya.B., 2:40963, 2:40967
Serenius, R., *See* Liu, M.S., 2:41172
Serlemitsos, P.J., *See* Holt, S.S., 2:42160
See Kaluzienski, L.J., 2:42158
Serov, G.V., *See* Mizin, V.G., 2:40828
Serova, N.B., *See* Zharova, M.N., 2:40806
Serper, A., Selected aspects of waste heat management. Summary report, 2:41254 (PB—254401)
Selected aspects of waste heat management: a state-of-the-art study. Final report, 2:41276 (PB—2556097)
Sethna, H.N., India's nuclear power programme and constraints encountered in its implementation, 2:41369 (IAEA-CN—36/385)
Shah, B.L., Coal resources for the fertilizer plant at Korba, Madhya Pradesh, 2:40868
Shah, K.R., *See* Filby, R.H., 2:41027
Shah, Y., *See* Ponder, T.C. Jr, 2:41278
Shahrokhi, F., *See* Sheppard, J.D., 2:41534
Sharma, R.P., *See* Sodha, M.S., 2:42268
Sharovarov, G.A., *See* Nesterenko, V.B., 2:41521
Sharp, R.D., *See* McNally, J.R. Jr., 2:41152
Shatsillo, V.G., *See* Dolgov, V.V., 2:41122
Shcherbinin, B., *See* Barbur, I., 2:41301
Shea, J., *See* Childers, K., 2:41924
Shea, M.A., Summary of cutoff rigidities calculated with the International Geomagnetic Reference Field for various epochs. Environmental research papers, 2:42148 (AD-A—028978)
Sheih, C.M., Application of a lagrangian statistical trajectory model to the simulation of sulfur pollution over the northeastern United States, 2:41958 (ANL—75-60(Pt.4), pp 37-41)
Puff-on-cell model for computing pollutant transport and diffusion, 2:41959 (ANL—75-60(Pt.4), pp 42-46)
See Hicks, B.B., 2:42014
Sheinbaum, I., Direct contact heat exhangers in geothermal power production, 2:41238
Shell, V.G., *See* Pease, L., 2:41518
Shelton, E.M., Aviation turbine fuels, 1976, 2:40998 (BERC/PPS—77/2)
Shelton, R.N., *See* Bader, S.D., 2:41808

Shepeleva, E.S., *See* Sanin, P.I., 2:41003
Sheppard, J.D., Quarterly progress report on advanced two-phase instrumentation program for November—December 1976, 2:41534 (ORNL/NUREG/TM—93)
Sherman, I.S., *See* Rundo, J., 2:42108
Sherwood, D.G., Magnetic jack control rod drives, 2:41491
Shibanov, A.N., *See* Chekalin, N.V., 2:41916
Shifrin, V.A., *See* Filonenko, Yu.Ya., 2:40824
Shifrine, M., Immune competence of ^{226}Ra-injected dogs and age-matched controls as measured by the micro-lymphocyte stimulation test, 2:42087 (UCD—472-123, pp 85-86)
Lymphoid colonies, 2:42039 (UCD—472-123, pp 61-65)
See Thilsted, J.P., 2:42065
Shih, D.S., *See* Dasgupta, R., 2:42032
Shimada, R., *See* Kobayashi, T., 2:42292
See Tani, K., 2:42303
Shimazu, H., Sodium-water reaction test facility (SWAT-3), 2:41548
Shimbarev, E.V., *See* Kapshukov, I.I., 2:41857
See Sudakov, L.V., 2:41834
Shimizu, H., *See* Inaba, H., 2:41852
Shin, P.Ch., *See* Kondrat'ev, A.A., 2:40942
Shinn, J.M. Jr., *See* Allred, J.W., 2:41204
Shipitsyn, V.I., *See* Sycheva, A.M., 2:40944
Shishkin, G.G., Instability of electron disturbances in an accelerator with an electron closed drift, 2:42249
Shnaper, B.I., Some questions of the nonfuel processing of brown coals of the Dneprovskii basin, 2:40804
Shnyrev, P.D., Durability of tungsten—cobalt carbide alloys, 2:41785 (N—76-28369)
Shoemaker, H.D., Mechanical properties of coal for simulation of underground gasification processes, 2:40815 (MERC/SP—76/3, pp 316-327)
Shore, M.L., Quadrennial report of the division of biological effects, 1971—1974, 2:42078 (PB—258436)
Shramko, V.M., Probabilities of states of a bunker in transient conditions, 2:40884
Shuck, L.Z., In Situ Hydrocarbon Recovery Simulation Laboratory research at Morgantown Energy Research Center, 2:40779 (MERC/SP—76/3, pp 452-466)
Proceedings of second annual underground coal gasification symposium, 2:40745 (MERC/SP—76/3)
Status of the MERC in situ gasification of Eastern U.S. coals project, 2:40750 (MERC/SP—76/3, pp 65-85)
See Advani, S.H., 2:40765, 2:40813
See Huston, J.C., 2:40784
See Shoemaker, H.D., 2:40815
Shulakov, N.V., *See* Glebov, I.A., 2:41560
Shuman, M.S., Sensors for continuous monitoring of toxic ions, nutrients, and dissolved gases in water, 2:42015 (PB—254834)
Shumway, R.W., *See* Solbrig, C.W., 2:41553
Shvarts, N.M., *See* Karaseva, E.Z., 2:40818
Shvidkovskaya, T.E., *See* Gorchakov, Y.V., 2:42151
Siddiqee, W, *See* Korsak, A.J., 2:41705
Sidik, S.M., Meteorological adjustment of yearly mean values for air pollutant concentration comparison, 2:41964 (N—76-29738)
Sidorenko, V.A., *See* Aleksandrov, A.P., 2:41438
Siemon, S.R., *See* Swann, P.D., 2:40847
Sikri, A.P., *See* Wieber, P.R., 2:40746
Silberman, D., *See* Fisher, G.L., 2:41983, 2:42120
Silin, V.P., *See* Bajkov, I.S., 2:42219
See Pustovalov, V.V., 2:42257
Silver, H.B., *See* Mould, R.W., 2:41026
Silvestri, A., Formulation and computer methods of load flow studies, 2:41289
Simmons, G.A. Jr, *See* Fairchild, J.E., 2:41684
Simmons, G.L., Significant actinide and daughter activities from the HTGR fuel cycle, 2:41362 (PB—258150)
Simon, J., Method for measuring the solar absorption factor, 2:41225 (N—76-27433)
Simon, R.H., *See* Rickard, C.L., 2:41513
Simons, W.H., *See* Feldmann, H.F., 2:40792
Simonsic, G.A., *See* Fries, R.J., 2:41149
Simpson, D.E., *See* Roake, W.E., 2:41512
Sindelar, F.L., *See* Fisher, D.K., 2:41938
Sinel'nikov, L.Z., *See* Averina, M.V., 2:40960
Singer, G.M., Naturally occurring nitrosatable amines. II. Secondary amines in tobacco and cigarette smoke condensate, 2:41867
Singer, J.M., *See* Chaiken, R.F., 2:40908, 2:40912
Singh, A.K., *See* Anderson, J.C., 2:41541
Singh, J.J., Investigation of size-dependent concentration of trace elements in aerosols emitted from the oil-fired heating plants, 2:40986 (N—76-27720)
Sinha, A.K., *See* Bahar, L.Y., 2:41542
Sinha, K.K., *See* Kondal Rao, N., 2:41086
Sinha, S.K., *See* Bader, S.D., 2:41808
Siniakova, S.I., *See* Terechov, G.I., 2:41805
Sipe, C.R., *See* Chandra, P., 2:42042
Sirges, H., Winning and stowing at 'Bergbau '76' exposition, 2:40892
Sirianni, A.F., *See* Capes, C.E., 2:40739, 2:40740, 2:40904
Siryi, P.O., Prospects of development of gas turbine installations in the USSR, 2:41267
Sisterson, D.L., Structure of the urban moisture field, 2:41957 (ANL—75-60(Pt.4), pp 34-36)
See Hess, G.D., 2:41952
Sklarew, R.C., Air quality models required data characterization. Final report, 2:41968 (PB—255730)
Sklizkov, G.V., *See* Basov, N.G., 2:42221
Skopp, G.H., *See* Pan, Y.S., 2:41473
Skovorodin, G.B., *See* Chertkov, Ya.B., 2:40963
Skripchenko, G.V., *See* Davydova, Zh.A., 2:40831
Slack, F.F., ATS-6 40- and 360-MHz differential phase measurements. Environmental research papers, 2:42176 (AD-A—030739)
Slater, C.O., Analysis of a fuel-pin neutron-streaming experiment to test methods for calculating neutron damage to the GCFR grid plate, 2:41379 (CONF-770401—6)
Slitenko, A.F., *See* Kapinos, V.M., 2:41918
Sloan, L.J., New design for interfacing computers to the Octopus network, 2:42334 (UCRL—79161)
Slonneger, B.E., Algorithm for cost effectiveness of directional versus vertical well drilling, 2:40785 (MERC/SP—76/3, pp 519-525)
See Huston, J.C., 2:40784
Sluijter, F.W., *See* Lambert, A.J.D., 2:42262
Smallwood, H.A., *See* Stone, R., 2:42012
Smart, D.F., *See* Shea, M.A., 2:42148
Smatlak, S., Main ways of nuclear power development, 2:41310 (INIS-mf—3391, pp 69-87)
Smetana, Z., *See* Sechovsky, V., 2:41803
Smidt, D., *See* Birkhofer, A., 2:41515
Smirnova, E.S., *See* Baturov, B.B., 2:41449
Smith, B.W., Hot interstellar tunnels. 1. Simulation of interacting supernova remnants, 2:42154 (N—76-29084)
Smith, C.R.F., *See* Holmes, J.T., 2:41426
Smith, D.R., SGHWR safety design and evaluation, 2:41514 (IAEA-CN—36/73)
Smith, E.T., Computer simulation of environmental impact, 2:42017
Smith, G.R., *See* Schlain, D., 2:41816
Smith, H.G., Phonon anomalies in transition metals, alloys, and compounds, 2:41809
Smith, J.D., Physical oceanography and sediment transport on the Washington continental shelf. Report of progress, October 1975—September 1976, 2:42146 (RLO—2225-T25-18)
Smith, L.L. Jr, *See* Broderius, S.J., 2:42123
Smith, L.M., Technology for using sulfate waste in highway construction. Final report, 2:40850 (PB—254815)
Smith, M.F., Coal mine waste (a bibliography with abstracts). Report for 1964—Nov 1976, 2:40870 (NTIS/PS—77/0040)
Sea water corrosion. Volume 1. 1964—1975 (a bibliography with abstracts). Report for 1964—1975, 2:41815 (NTIS/PS—77/0052)
Smith, R., *See* Hunt, W.F. Jr, 2:41992
Smith, R.A., Analysis of critical heat flux in flow reversal transients, 2:41545
Smolensky, P., *See* Cicchetti, C.J., 2:41274
Smotriskaya, E.S., *See* Chebotarev, N.T., 2:41765
Snell, N.S., Network capability estimation. Vela network evaluation and automatic processing research. Technical report, 2:41948 (AD-A—034897)
Sodha, M.S., Generation of plasma waves by Gaussian laser beam and stimulated Raman scattering, 2:42268
Soerensen, O.T., Thermodynamic studies at higher temperatures of the phase relationships of substoichiometric plutonium and uranium/plutonium oxides, 2:41848
Sohns, H.W., *See* Carpenter, H.C., 2:41051
Sokolov, V.I., *See* Gulyaeva, N.D., 2:40832
Sokolov, V.N., *See* Galkin, B.Ya., 2:41132
See Proskulryakov, V.A., 2:41067
Sokolov, Yu.A., *See* Alikaev, V.V., 2:42214
Sokolowski, J., *See* Berestka, A., 2:40921
Sokolsky, S., Energy savings resulting from modal shifts to Corridorrail, 2:41739 (PB—257409)
Sola, A., *See* Cecille, L., 2:41133
Solbrig, C.W., Prediction of reflood heat transfer with standard loop programs, 2:41553
Sole, T.L., Hydrogeologic assessment of an underground coal gasification project site Grant District, Wettzel County, W. Va., 2:40855 (MERC/SP—76/3, pp 140-144)
Solomon, D.E., *See* Nolen, R.L. Jr., 2:42304
Sommer, D., Comparison of the power distribution in uranium and plutonium fuel elements in the KWO core, 2:41485
Sommerer, D.K., *See* Gooding, C.H., 2:41279
Sonnino, T., Guidelines for forecasting energy demand, 2:41627 (IA—1327)
Sophronova, R.M., Shear martensitic transformation in uranium alloys during quenching, plastic deformation and low temperature annealing, 2:41776
Sorokin, P.P., Resonantly enhanced, nonlinear generation of tunable, coherent, vacuum ultraviolet (vuv) light in atomic vapors, 2:41912
Soulhier, R., *See* Moreau, C., 2:41084
Sourieau, P., *See* Combarnous, M., 2:40933
Soutar, P.S., Hydrocracking of residual oils and tars. III. The effect of mineral matter on the thermal and catalytic

hydrocracking of Athabasca bitumen, 2:41061
Hydrodesulphurization of heavy gas-oils (650-975°F) derived from Athabasca bitumen, 2:41057
See McColgan, E.C., 2:41062, 2:41063
Spalding, I.J., Filling of toroidal traps with laser plasmas, 2:42301 (AED-Conf—76-506-003)
Spalthoff, F.J., Fuel cycle of the LWR system in the Federal Republic of Germany, 2:41111 (IAEA-CN—36/95)
Spangler, W., *See* Chrisp, C.E., 2:42089
Spangler, W.L., *See* Shifrine, M., 2:42039
Spaulding, M., Numerical modeling of pollutant transport using a Lagrangian marker particle technique, 2:42006 (N—76-28682)
Spaziani, J.C., *See* Tulenko, J.S., 2:41346
Spedding, F.H., Heats of dilution of some aqueous rare earth electrolyte solutions at 25°C. I. Rare earth perchlorates, 2:41873
See Rard, J.A., 2:41874, 2:41877
Speight, J.G., Some observations on the hydroprocessing of a heavy crude oil, 2:41064
Spencer, J.D., *See* Berber, J.S., 2:40812
Spendlove, M.J., Recycling trends in the United States: a review. Information circular 1976, 2:41692 (PB—254222)
Spiegel, V., *See* Grundl, J.A., 2:41154
Spiegel, W.F., Air quality and heat transfer, 2:41593 (NSF-RA—760006, pp 247-256)
Spierling, H., *See* Stehle, H., 2:41318
Spight, C., Research program in magnetogasdynamics utilizing hypervelocity coaxial plasma generators. Final report, 2:41660 (N—76-25019)
Spitsyn, V.I., Scientific prerequisites and practice for using deep water-bearing horizons for disposal of liquid radioactive wastes, 2:41139 (IAEA-CN—36/345)
Spitz, H.B., *See* Cohen, N., 2:42107
Spyrou, O., Analytical investigation of the optical mixing of two laser beams of identical frequencies in a spatially homogeneous collisionless plasma, 2:42222
Squire, G.R., *See* Mills, T.R., 2:41999
Srinivasan, M.R., *See* Sethna, H.N., 2:41369
Srivastava, R.D., *See* Misra, A.K., 2:41004
Srivenkatesan, R., *See* Kati, S.L., 2:41522
Sroka, J.M., *See* Mosby, J.F., 2:40958
Stacey, R.J., *See* Robinson, A.C., 2:41775
Stadler, H.G., Natural gas pipeline through Lake Traun, 2:41046
Stadnik, V.F., Gas distributor grids for high-temperature processes in fluidized bed, 2:40946
Stanchi, L., Effluent and sanitary sewer monitors, 2:42013 (LA—6638-M)
Stanfield, C.P., List of Louisiana oil and gas fields and salt domes including the offshore areas showing code numbers and official abbreviations, 2:41646
Stangeland, B.E., Kinetic model for the prediction of hydrocracker yields, 2:40957
Stanhouse, R.W., Conceptual approach study of a 200-watt-per-kilogram solar array. Quarterly report, 2:41187 (N—76-28651)
Stanley, A.G., Irradiate-anneal screening of total dose effects in semiconductor devices, 2:41935 (N—76-28223)
Stanley, J.A., Present status of and future plans for ITRI's human and dog chest counting facilities, 2:42106 (BNWL—2088, pp 151-156)
Staszak, L.A., *See* Kain, H.R., 2:41715
Stears, J.H., Roof-fall resupport accidents, a study. Information Circular, 1976, 2:40880 (PB—262119)
Steers, L.L., Study of aerodynamic drag reduction on a full-scale tractor-trailer. Final report, Mar—Dec 1974, 2:41741 (PB—254571)
Stehle, H., Experience with Pu-recycle fuel for large light water reactors in the Federal Republic of Germany, 2:41318 (IAEA-CN—36/558)
Steinmetz, W., Effect of the stroke/bore ratio in a vehicle diesel engine with special regard to the combustion process in a hyperboloid combustion chamber, 2:41745
Steitler, R.W., *See* Land, R.E., 2:41343
Stejskal, J., *See* Neumann, L., 2:41134
Stello, V. Jr., Recent U.S. reactor operating experience, 2:41309 (IAEA-CN—36/483)
Stephens, D.R., LLL in-situ coal gasification program, 2:40749 (MERC/SP—76/3, pp 53-64)
Stephens, F.S., Experimental status of high-spin states, 2:42197 (Juel-Conf—16(Vol.2), pp 11-33)
Stephens, L.W., *See* Fairchild, J.E., 2:41684
Stern, M.O., *See* Doggett, R.M., 2:41599
Sterner, T.E., *See* Humphrey, A.E., 2:40770
Stevens, D.D., *See* Cross, J.L., 2:41736
Stevens, L., *See* Michel, A., 2:41403
Stewart, I.M., In-situ gasification in Australia: prospects, potential, and research activities, 2:40774 (MERC/SP—76/3, pp 382-387)
Stewart, R.E.D., Utilization of low BTU gas from in-situ coal gasification for on-site power generation, 2:40773 (MERC/SP—76/3, pp 372-379)
Stick, T.L., Ionospheric R-region electron density and neutral atmosphere variations, 2:42181 (N—76-27753)
Sticksel, P.R., *See* Schorr, J.R., 2:41977
Stirn, R.J., High-efficiency thin-film GaAs solar cells. Interim report No. 2, 1 Apr—30 Jun 76, 2:41191 (PB—258493)
Stitzel, K.A., *See* Wilson, F.D., 2:42081
Stober, E., *See* Kriechbaum, K., 2:41314
Stoeckel, P., *See* Hoppe, W., 2:42027
Stokinger, H.E., Toxicology of diesel emissions, 2:41749
Stoll, W., *See* Stehle, H., 2:41318
Stomma, J., *See* Okrajni, S., 2:40934
Stone, R., Treatment effectiveness for the removal of selected contaminants from drinking water. Final report, 2:42012 (PB—258271)
Storm, E.K., *See* Ahlstrom, H.G., 2:42308
Stott, G., *See* Mitchell, N.T., 2:41136
Stover, J., Residential space heating: a decision model of the dynamics of fuel penetration, 2:41676
Strang, J.R., *See* Barton, D.B., 2:41009
Stratton, W.R., *See* Roake, W.E., 2:41512
Strauss, M.G., *See* Rundo, J., 2:42108
Strebkova, T.F., *See* Nechaev, L.V., 2:41719
Streibl, B., *See* Duesing, G., 2:42297
Streit, G.E., *See* Wells, J.S., 2:41906
Stretanski, E.D., *See* Keller, D.V., 2:41926
Strickland, C.I., *See* Keyes, J.H., 2:41218
Strickland, R.G., *See* Keyes, J.H., 2:41218
Strindehag, O., Liquid coupled system for heat recovery from exhaust gases, 2:41670
Stuart, B.O., Selection of animal models for evaluation of inhalation hazards in man, 2:42129
Stuhmiller, J.H., A review of the rational approach to two-phase flow modeling. Topical report, 2:41457 (PB—255548)
Stuhrmann, H.B., Small-angle scattering of proteins in solution, 2:42025 (BNL—50453, pp IV.3-IV.19)
Sturgeon, R.F., Study of the application of advanced technologies to laminar flow control systems for subsonic transports. Volume I. Summary. Final report, 2:41681 (N—76-24144)
Study of the application of advanced technologies to laminar-flow control systems for subsonic transports. Volume 2. Analyses. Final report, 2:41682 (N—76-24145)
Sturm, R.J., Comprehensive formalism for the analysis of recoil-distance lifetimes, 2:42198
Sturrock, P.A., Study of the relationship between solar activity and terrestrial weather, 2:42165 (N—76-28742)
Sturzinger, C., Feed and condensate pumps in nuclear power stations, 2:41322 (SIGLUT-P—719)
Subramanyam, R.B., *See* Kondal Rao, N., 2:41086
Suchard, S.N., *See* Capelle, G.A., 2:41167
Sudakov, L.V., New phases in curium-oxygen system, 2:41834
See Kapshukov, I.I., 2:41857
Sudarev, A.V., Calculation of flame tube temperature of a multiregister combustion chamber, made by Nevskii Engineering Works, with a swirl mixer, 2:41264
Suita, T., Programme and current status of fast breeder reactor development in Japan, 2:41392 (IAEA-CN—36/164)
Sukhov, V.A., *See* Davydova, Zh.A., 2:40831
Sukhuja, R., *See* Nydick, S.E., 2:41247
Sun, C.L., *See* Bertsch, O.L., 2:41475
Sunder Rajan, N.S., *See* Thomas, K.T., 2:41123
Sunderman, F.W. Jr., Review of the carcinogenicities of nickel, chromium, and arsenic compounds in man and animals, 2:42132
See Gitlitz, P.H., 2:42126
Suski, W., Magnetic ordering in the actinide intermetallics, 2:41804
Sutinen, J.G., *See* Gates, J.M., 2:41283
Sutterlin, M., *See* Lehr, J., 2:42136
Sutton, K.W., Consultant's approach to total energy, 2:41667
Snuberg, E.M., *See* Bush, T.W., 2:40743
Suzuki, M., *See* Irie, H., 2:41041
Suzuki, N., *See* Miyazu, T., 2:40734
Suzuki, Y., *See* Hamada, Y., 2:42241
Svetlov, V.D., *See* Kondrashin, A.V., 2:41271
Svidchenko, A.I., *See* Bogatov, G.F., 2:40999
Svoboda, V., In-service inspection and diagnostics of A-1 power plant blowers, 2:41373 (INIS-mf—3389, pp 56-65)
Svyatets, I.E., Question of the determination of the apparent density of brown and hard coals, 2:40820
Swaminathan, N., *See* Kondal Rao, N., 2:41086
Swank, J.H., *See* Holt, S.S., 2:42160
Swann, P.D., Compound isolation from brown coal by low-temperature evacuation, 2:40847
Swinth, K.L., Development of an anthropomorphic phantom for the calibration of external detectors for the in vivo measurement of plutonium, 2:42114 (BNWL—2088, pp 235-241)
Effects of plutonium redistribution on lung counting, 2:42110 (BNWL—2088, pp 199-205)
Proceedings of the workshop on measurement of heavy elements in vivo, 2:42093 (BNWL—2088)
Switkowski, Z.E., Mass fractionation of the lunar surface by solar wind sputtering, 2:42150 (N—76-31119)
Sycheva, A.M., Experience in operating catalytic reforming reactor with radial feed input and thin bed of catalyst, 2:40944
Syrett, R.J., *See* Mould, R.W., 2:41026

Syskov, K.I., *See* Mizin, V.G., 2:40828
Syuzev, V.N., *See* Zaimovskii, A.S., 2:41444
Szabo, B., *See* Szili, G., 2:41305
Szarafinski, Z., Technical progress in development of mechanical coal preparation in Poland in the five year period 1971-1975, 2:40901
Szczuka, A.E., Concept feasibility study for training equipment to improve coal productivity. Volume I. Final report, 2:40876 (PB—254863)
Concept feasibility study for training equipment to improve coal productivity. Volume 2. Appendices. Final report, 2:40877 (PB—254864)
Szego, G.C., Feasibility of meeting the energy needs of army bases with self-generated fuels derived from solar energy plantations. Final report, 2:41196 (AD-A—031163)
Feasibility of meeting the energy needs of army bases with self-generated fuels derived from solar energy plantations (Appendices D, E, F, G, and H). Final report, 2:41197 (AD-A—031211)
Szili, G., Development of the national nuclear programme and preparations for the introduction of nuclear power in Hungary, 2:41305 (IAEA-CN—36/420)
Szili, Z., *See* Drouet, M.G., 2:42244
Szwedzicka, M., Geological and mining conditions of coal deposits in safety pillars in the Upper Silesian coalfield, 2:40866

T

Taft, P.H., Compilation of solar data for White Sands Missile Range, 2:41232 (AD-A—029155)
Tagirova, R.H., *See* Terechov, G.I., 2:41805
Tait, G.D., *See* Bartlett, D.V., 2:42228
Takahashi, H., Status for seismic design requirements of nuclear power plants in Japan, 2:41517 (IAEA-CN—36/159)
Takeda, S., *See* Kato, Y., 2:41416
Takeda, T., *See* Kato, Y., 2:41416
See Kobayashi, T., 2:42292
See Tani, K., 2:42303
Takematsu, T., Comparison of bottom-feed and top-feed reaction systems for hydrodesulphurization, 2:41058
Takeya, K., *See* Taniguchi, K., 2:42073
Talibdzhanov, Z.S., *See* Akhmedov, R.B., 2:41031
Talvari, A.F., *See* Pobul, L.Ya., 2:41065
Tamaki, M., *See* Kirihara, T., 2:41858
See Nasu, S., 2:41843
Tammemagi, H.Y., *See* Tomlinson, M., 2:41116
Tanaka, K., *See* Kikuchi, Y., 2:41527
Tanaka, S., Propagation characteristics of cold lower hybrid waves in linear tokamak plasmas, 2:42270
Tang, T.W., *See* Wong, K.C., 2:42269
Tang, W.M., *See* Cohen, B.I., 2:42250
Tani, K., Power supply to the air-core transformer coils of a large tokamak by a multi-stage inductive energy storage system. Optimal design of the electric circuits by a simplex method, 2:42303 (JAERI-M—6467)
See Kobayashi, T., 2:42292
Taniguchi, K., Analysis of the developmental stage of specific and nonspecific cytotoxicity. I. Separation of the developmental steps of specific cytotoxicity by susceptibility to irradiation, 2:42073
Tao, B.Y., *See* Chrusciel, W.A., 2:42296
Tapia, R.A., Extension of quasi-Newton methods to constrained optimization and to general systems of nonlinear equations and inequalities. Progress report, February 1, 1976—January 31, 1977, 2:42328 (ORO—5046-1)
Tarasov, B.G., Nature and distribution of self-potential in worked coal seams, 2:40865
Tasci, M.T., *See* Grose, L.T., 2:41234
Tate, V.H., Multi-satellite attitude prediction program/Orbiting Solar Observatory-8 (MSAP/OSO-8) operating guide, 2:42164 (N—76-27304)
Tatry, B., Energy storage: feasibility study to collect, store and release energy from solar origin, using a kinetic battery stockage, 2:41565 (N—76-27695)
Taube, M., Transmutation of strontium-90 and cesium-137 in a high-flux fast reactor with a thermalized central region, 2:41460
Taylor, B.G., *See* Andresen, R.D., 2:41928
Taylor, J.R.M., *See* Salter, S.H., 2:41242
Taylor, N.J., *See* Shifrine, M., 2:42039, 2:42087
Taylor, R., Analytic modeling of electrically excited D_2/HCl and HCl laser experiments. Final report, 1 Aug 1974—31 May 1976, 2:41897 (AD-A—034674)
Taylor, R.W., Gas quality and geochemical studies in gas-stimulation experiments, 2:41040
See Bozak, R.E., 2:41039
Tazima, T., *See* Tani, K., 2:42303
Teague, H.J., *See* Bailly, J., 2:41519
Teague, J.R., 1.06 micrometer wideband laser modulator: fabrication and life testing. Final report, 25 Jul 1974—25 Jul 1975, 2:41904 (N—76-27538)
Teare, J.D., *See* Taylor, R., 2:41897
Telfer, N., *See* Payne, J., 2:42061
Tempelmeyer, K.E., *See* Dicks, J.B., 2:41659
Tenret-Noel, C., *See* Verbist, J.J., 2:41850
Terechov, G.I., Thermoelectric properties of solid solutions based on uranium and thorium, 2:41805
Terent'ev, A.A., *See* Lishtvan, I.I., 2:40807
Terichow, O.N., *See* Buder, M.K., 2:40754
Terumichi, Y., *See* Tanaka, S., 2:42270
Tesche, F.M., Internal interaction analysis: topological concepts and needed model improvements. Final report, 2:41932 (AD-A—027047)
Tesche, T.W., *See* Ogren, J.A., 2:41978, 2:41979, 2:41980, 2:41981, 2:41982
Tesner, P.A., Kinetics of the formation of pyrocarbon from methane, 2:41168
Testa, G., *See* Mangiagalli, D., 2:41320
Tewksbury, E.J., *See* Barton, D.B., 2:41009
Tezuka, S., Performance of an evaporative cooler, 2:41256
Thangavelu, K., System analysis, design, and operation of automated guideway transit systems, 2:41707
Thayer, W.L., Enthalpy and heat capacity of liquid plutonium and uranium, 2:41806
Thekaekara, M.P., *See* Heath, D.F., 2:42169
Theus, R., *See* Parks, N.J., 2:42125
Thilsted, J.P., Leukocyte migration inhibition assay, 2:42065 (UCD—472-123, pp 87-88)
Thoene, R., *See* Bock, H.W., 2:41490
Thom, G., *See* Hunt, W.F. Jr, 2:41992
Thomas, E.W., *See* Barnett, C.F., 2:42231
Thomas, J.K., *See* Edwards, H.E., 2:42037
Thomas, J.M., *See* Gore, K.L., 2:41313, 2:41492
Thomas, K.S., *See* Krakowski, R.A., 2:42283
Thomas, K.T., Management of radioactive wastes: an overview of the Indian programme, 2:41123 (IAEA-CN—36/388)
Thompson, C.J., *See* Dooley, J.E., 2:41021, 2:41022
See Hirsch, D.E., 2:41023
See Lanning, W.C., 2:41639
Thompson, D.C., Core restraint development. Quarterly progress report for period ending November 30, 1976, 2:41407 (WARD-CR—3045-15)
Thompson, P.N., Prospects and problems for UCG in Britain, 2:40775 (MERC/SP—76/3, pp 388-401)
Thompson, R.G., Economic analysis of environment and energy in the petroleum refining, electric power, and chemical industries, 2:41638
Thompson, T.W., Rock mechanics aspects of in-situ gasification with special reference to Texas lignite, 2:40768 (MERC/SP—76/3, pp 306-315)
See Edgar, T.F., 2:40752
Thor, G., *See* Altmann, W., 2:41249
Thorne, K.S., The relativistic equations of stellar structure and evolution. stars with degenerate neutron cores. I. Structure of equilibrium models, 2:42152 (N—76-27134)
Thorne, W.L., Pressure drop measurements in FFTF fuel vibration tests, 2:41500 (HEDL-TC—812)
Thornton, H.P., Drilling in the St Lawrence Lowlands of Quebec, 2:40920
Thornton, S.T., Nuclear and Coulomb deformation parameters in ^{142}Nd, 2:42205
Thorsness, C., *See* Rozsa, R., 2:40777
Thring, M.W., Thermionic conversion, 2:41662
Thuemmler, F., *See* Dienst, W., 2:41822
Tiede, J.J., Robust calibration. Technical report, 2:42059 (AD-A—031114)
Tien, C.L., *See* Dua, S.S., 2:41547
Tietjen, G.L., Variances and covariances of the normal order statistics for sample sizes 2 to 50, 2:42327 (LA—6482-MS)
Till, J.E., Laboratory technique for obtaining fathead minnow eggs for use in toxicity experiments, 2:42130
Ting, J.W.S., *See* Davis, J.M., 2:41929
Tinkham, M., Superconductors, magnetic detectors and magnetic electronics. Final report, 2:42210 (AD-A—034361)
Tinlin, R.M., *See* Todd, D.K., 2:42010
Titov, S.G., *See* Gomozov, L.I., 2:41837
To, J.K.W., Minimum weight design of cooling towers, 2:41253 (N—76-30612)
Toda, Y., Study by density measurement of changes in pore structures of coals with heat treatment. II. Micropore structure, 2:40838
Todd, D.K., Monitoring groundwater quality: monitoring methodology. Final report, 2:42010 (PB—256068)
Toebbe, H., *See* Michel, A., 2:41403
Toffer, H., Criticality control and long term storage of spent fuel, 2:41105 (IAEA-CN—36/33)
Tokarev, Yu.I., *See* Baturov, B.B., 2:41449
Tolpygo, V., *See* Barbur, I., 2:41301
Tombrello, T.A., *See* Switkowski, Z.E., 2:42150
Tomlinson, F.K., Calibration for plutonium-238 lung counting at Mound Laboratory, 2:42101 (BNWL—2088, pp 89-100)
Summary of discussion calibration techniques and errors I, 2:42100 (BNWL—2088, pp 85-87)
Tomlinson, M., Management of radioactive wastes from nuclear fuels and power plants in Canada, 2:41116 (IAEA-CN—36/178)
Tone, T., Preliminary study on power balance in the plasma of an

experimental fusion reactor, 2:42285 (JAERI-M—6453)
See Yamato, H., 2:42276
Tong, L.S., *See* Murley, T.E., 2:41530
Toohey, R.E., Use of ^{103}Pd as a calibration source for the determination of ^{239}Pu in vivo, 2:42097 (BNWL—2088, pp 53-62)
Torkildsen, R.A., *See* Dempsey, R.M., 2:40913
Toynbee, P.A., *See* Rees, D.M., 2:40903
Toyoda, H., *See* Irie, H., 2:41041
Toyomasu, K., *See* Kuriyama, Y., 2:41049
Toyota, M., *See* Aoki, S., 2:41526
Traccucci, R., *See* Brandt, R.C., 2:41334
Trainor, R.J., Calorimetric study of the intermetallic compounds UAl_2 and $PuAl_2$, 2:41807
Tran, M.Q., Propagation of ion acoustic solitons in a warm ion plasma, 2:42264
Propagation of ion acoustic solitons in a two component plasma, 2:42265
See Weibel, E.S., 2:42266
Trapani, R.J., *See* Clark, A.F., 2:41885
Trefilov, V.A., *See* Glebov, I.A., 2:41560
Trijonis, J.C., Utility of reactivity criteria in organic emission control strategies. Application to the Los Angeles atmosphere. Final report, 2:41971 (PB—257706)
Troc, R., *See* Zolnierek, Z., 2:41835
Trofimov, A.M., *See* Galkin, B.Ya., 2:41132
Trombka, J.I., Reanalysis of the Apollo cosmic gamma-ray spectrum in the 0.3 to 10 MeV energy region, 2:42149 (N—76-28148)
Trostnikov, A.A., *See* Posyl'nyi, V.Ya., 2:40825
Troyanov, M.F., *See* Bakumenko, O.D., 2:41396
Troyon, F., *See* Berger, D., 2:42239
Trubnikov, V.P., *See* Nesterenko, V.B., 2:41521
Tsai, S.S., Potential for penetration of a hot vapor jet into a subcooled liquid, 2:41551
Tsang, T.H., *See* Edgar, T.F., 2:40764
Tschantz, B.A., *See* Minear, R.A., 2:40871
Tschirwitz, U., *See* Meier, H.U., 2:41664
Tseung, A.C.C., Oxygen evolution on semiconducting oxides, 2:41578
Tsikunov, A.G., *See* Bakumenko, O.D., 2:41396
Tsuboi, K.K., *See* Parks, N.J., 2:42064, 2:42090, 2:42125
Tsujino, T., *See* Nomura, S., 2:41357
Tsykanov, V.A., *See* Zaimovskii, A.S., 2:41444
Tu, D.K., Numerical simulation of tornado-borne missile impact, 2:41881 (UCRL—52223)
Tucker, C., *See* Zahradnik, J.W., 2:41699
Tulenko, J.S., Fuel performance in Babcock and Wilcox pressurized water reactors, 2:41346
Tumanovskii, A.G., *See* Bodrov, I.S., 2:41268
Turbas, E., Chemical composition and effectiveness of oil shale ash and cement kiln flue dust as liming fertilizers, 2:41069 (PB—254559-T/SL)
Turcotte, R.P., Alpha radiation damage in the actinide dioxides, 2:41859
Turnbull, L.S. Jr., Vela network evaluation and automatic processing research. Quarterly report No. 5, 10 Jul—10 Oct 1976, 2:41946 (AD-A—034769)
Turner, J.G., Parametric decay of whistler waves, 2:42263
Turner, J.M., *See* Burlaga, L.F., 2:42174
Turner, L.S., *See* Zahradnik, J.W., 2:41699
Turner, R.F., *See* Lotts, A.L., 2:41359
Turricchia, A., Trends in the development of reactor containments, 2:41469 (IAEA-CN—36/306)
Tverkovkin, B.E., *See* Krasin, A.K., 2:41397
Twardowski, K., Methodology of reservoir rocks separation in the miocene profile of the carpathian foothills using multiple regression analysis, 2:40924
Tyrer, F.H., Cautionary tale of a lead hazard in recycling of waste, 2:42134

U

Uematsu, K., *See* Amanuma, T., 2:41303
Ukechi, K., *See* Shimazu, H., 2:41548
Underhill, A.B., Line identifications in the ultraviolet spectra of tau Herculis, B5 IV, and zeta Draconis, B6 III, 2:42155 (N—76-29099)
Ungers, L.J., Area source emission inventory for Dougherty County, Georgia. Volume I, 2:41969 (PB—256004)
Ursprung, H., Deep water laying of steel pipe-lines using free fall technique, 2:41047
Usov, V.V., *See* Prilutskiy, O.F., 2:42161
Ustalov, V.V., *See* Romanyuk, L.I., 2:42261
Utkina, O.N., *See* Chebotarev, N.T., 2:41821
Uvarova, V.I., *See* Gridin, I.D., 2:41173

V

Vaccaro, G., *See* Campolunghi, F., 2:41410
Vacek, M., *See* Brumovsky, M., 2:41820
Valentin, P., *See* Pinegre, M., 2:42232
Valic, F., *See* Gentilizza, M., 2:41984
Valland, G., Materials and welding related to the construction of fixed offshore installations, 2:40936
van de Voorde, N., *See* Mergan, L.M., 2:41131
van den Bemden, E., *See* van Dievoet, J., 2:41445
Van Der Sluys, W.A., Determining fracture properties of reactor vessel forging materials, weldments, and bolting materials. Final report, 2:41783 (PB—257563)
van Dievoet, J., Plutonium use - present status and perspectives, 2:41445 (IAEA-CN—36/477)
van Domselaar, H.R., Analysis of the acidizing process in acid fracturing, 2:40939
Van Thiel, M., Generalized shaped charge design. Final report, October 1975—October 1976, 2:41940 (UCID—17379)
van Zant, G.E., Study of haemopoietic microenvironment in vitro, 2:42070
Vandenberg, C., *See* Bairiot, H., 2:41317
Vandorpe, M., *See* Mergan, L.M., 2:41131
Varga, I., *See* Szili, G., 2:41305
Varga, R.S., *See* Saff, E.B., 2:42336
Varshalovich, D.A., *See* Burdyuzha, V.V., 2:42162
Vasey, M.R., *See* Stanchi, L., 2:42013
Vasil'evskii, S.P., *See* Glebov, I.A., 2:41560
Vasilenko, K.T., *See* Kazachkovskii, O.D., 2:41398
Vaughan, G.L., *See* Minear, R.A., 2:40871
Vaughan, R.D., Need for high performance breeder reactors, 2:41402 (IAEA-CN—36/478)
Veal, B.W., Electronic structure of uranyl compounds - an XPS study, 2:41849
Veneruso, A.F., Simulation and operation of a solar powered organic Rankine cycle turbine, 2:41223
Veneziano, D., Probabilistic and statistical models for seismic risk analysis, 2:41537 (PB—259188)
Ventura, S.A., *See* Chrusciel, W.A., 2:42296
Verbist, J.J., Bonding and valence in uranium compounds with oxygen: a study by X-ray photoelectron spectroscopy and electron paramagnetic resonance, 2:41850
Verdeyen, J.T., *See* Crane, J.K., 2:41900
Verkerk, B., Reprocessing of fission material: a look at the European situation, 2:41102
See Hamstra, J., 2:41137
Verkhovykh, P.M., *See* Reshetnikov, F.G., 2:41085
Verneau, A., Possible use of expansion turbines in gas and petroleum industries, 2:40947
Vetter, O., *See* Altmann, W., 2:41249
Vig, B.K., *See* Sander, C., 2:42043
Vikhrev, Yu.V., *See* Semenovker, I.E., 2:41270
Villani, A., *See* Mangiagalli, D., 2:41320
Virgil'ev, Yu.S., *See* Averina, M.V., 2:40960
Viseur, R., *See* Charrault, J.C., 2:41304
Visser, W., *See* van Domselaar, H.R., 2:40939
Vitberg, A.K., Implementing 'best management practices' for residuals: the waste exchange, 2:41696 (PB—258068)
Vitti, G.E., *See* Roberts, R., 2:41750
Vivante, C., *See* Charrault, J.C., 2:41304
Vivian, G.A., *See* Tomlinson, M., 2:41116
Vlasenkov, V.S., Synchrotron radiation of runaway electrons in the TM-3 TOKAMAC, 2:42288
Vogelweith, L., Medium-size nuclear plants, 2:41333 (IAEA-CN—36/568)
Vogt, P.M., *See* Rupinskas, R.L., 2:41325
Vojtech, O., *See* Neumann, L., 2:41134
Volkov, Yu.A., *See* Brodskii, E.S., 2:40968
Vollath, D., Recovery processes in quenched and neutron irradiated uranium dioxide, 2:41855
Volodin, N.I., *See* Gridin, I.D., 2:41173
von Haebler, D., Design of KWU LWR safety systems, 2:41516 (IAEA-CN—36/132)
Vorwerk, K., *See* Eiden, H., 2:41262
Vroom, D.A., *See* Palmer, R.L., 2:41170
Vrugt, P.J., Shock tube study of the coefficient of thermal conductivity of helium, neon, argon and krypton, 2:42229 (INIS-mf—3404)
Vyrubov, D.N., *See* Orlin, A.S., 2:41712

W

Wachter, W.J., Development of the Super-Sipper in-core and out-of-core failed fuel detection systems, 2:41483
Wagadarikar, V.K., *See* Iyengar, P.K., 2:41306
Wagener, B., *See* Bentrup, F.K., 2:40895
Wagoner, C.L., Further development of the burning profile, 2:40910
See Downs, W., 2:40900
Wakabayashi, N., *See* Smith, H.G., 2:41809
Walker, A.C., *See* Spalding, I.J., 2:42301
Walker, G.H., *See* Byvik, C.E., 2:41160
Wallace, B., Gene control mechanisms and their possible bearing on the neutralist-selectionist controversy, 2:42046
Wallenberg, B., *See* Nordstrom, B., 2:41443
Walmer, D.K., Influence of melatonin on erythropoiesis, 2:42030
See Berkut, M.K., 2:42029
See O'Shea, M.D., 2:42031
Walsh, W.J., Metallic sulfide additives for positive electrode material within a secondary electrochemical cell, 2:41577

Walters, E.A., Development of high pressure liquid chromatographic techniques. Final report, 2:41870 (AD-A—026899)
Walukas, D.J., Assessing the potential for optimal utilization of off-peak power. Volume I. Executive summary. Final report, 2:41650 (PB—254774)
Assessing the potential for optimal utilization of off-peak power. Volume II. Electrical loads offering major potential for the use of off-peak power. Final report, 2:41651 (PB—254775)
Wambsganss, M.W., *See* Halle, H., 2:41505
Wang, R., *See* Allen, R.P., 2:41759
Wang, S.D., *See* Artman, J.O., 2:41823
Wang, S.T., Bibliography on analysis and design of coal mine structures using finite element techniques, 2:40878 (PB—255944)
Ward, B.J., *See* Orme, J.T., 2:41774
Ward, D.A., *See* Smith, D.R., 2:41514
Ward, R., Federal fuels from biomass energy program, 2:41166
Ward, S., *See* Spalding, I.J., 2:42301
Wardlaw, C.H., *See* Carstarphen, C., 2:41708
Warren, J.H., Design of an insulated coaxial pipe assembly for a drilled geothermal wall, 2:41239
Warren, T.M., Hydraulic fracturing thin coal seams in preparation for in situ gasification, 2:40814 (MERC/SP—76/3, pp 300-305)
Warren, W.H. Jr, Photometric study of the Orion OB 1 association. 1. Observational data, 2:42153 (N—76-28125)
Warzinski, R.P., *See* Friedman, S., 2:40742
Washington, H., *See* Campbell, J.H., 2:40753
Watson, D.G., *See* Gore, K.L., 2:41313, 2:41492
Watson, G.B., *See* Carter, H.R., 2:41342
Watterson, J.B., Effects of oxygen contamination on gas dynamic laser performance, 2:41899 (AD-A—034900)
Webb, G.A.M., *See* Mitchell, N.T., 2:41136
Weber, C.W., *See* Petit, G.S., 2:41886, 2:41887
Weber, D.F., *See* Plewa, M.J., 2:42033
Weber, H.O., *See* Rard, J.A., 2:41874
Weed, R.I., *See* Chan, T.K., 2:42028
Wegrzyk, Z., Problem of safe undermining of seams in the light of practical experience gained in Nowy Wirek colliery, 2:40888
Wehling, J., *See* Bittermann, D., 2:41425
Weibel, E.S., Model of excitation of an acoustic wave by the 'double plasma' mechanism, 2:42266
Weicht, U., *See* Kietzer, K., 2:41528
Weidner, J.P., *See* Dariage, L.J., 2:40835
Weisberg, E., *See* Rosenberg, D.G., 2:40990
Weisenberg, I.J., Evaluation of SO_2 emission control technology applicable to the East Helena lead smelter. Final report, 2:41965 (PB—255277)
Weiss, A., *See* Vogelweith, L., 2:41333
Weiss, H.J., *See* Hans, R., 2:41414
Weisse, J., *See* Clement, M., 2:42225
Welford, W.T., *See* Micholas, D.J., 2:42307
Welhart, E.K., Advanced composites: mechanical properties and hardware programs for selected resin matrix materials, 2:41860 (N—76-24364)
Wells, J.S., Application of infrared frequency synthesis techniques with metal-insulator-metal diodes to the spin flip Raman laser, 2:41906 (PB—254066)
Wells, M.B., Build without destroying the Earth, 2:41592 (NSF-RA—760006, pp 211-232)
Wells, W.C., *See* Bridges, J.E., 2:41934
Wen, C.Y., *See* Feldmann, H.F., 2:40792
Went, J.J., Status and prospects of thermal breeders, 2:41395 (IAEA-CN—36/302)
Wentink, T. Jr., Wind power potential of Alaska. Part II. Wind duration curve fits and output power estimates for typical windmills, 2:41243 (RLO/2229/T12—76/1)
Werkoff, F., *See* Mercier, C., 2:42233
Werner, A.S., Preliminary environmental assessment of the CAFB. Final report, Aug 1975—May 1976, 2:40979 (PB—262001)
Wesely, M.L., Measurements of atmospheric turbidity in an arc downwind of St. Louis, 2:41955 (ANL—75-60(Pt.4), pp 22-30)
Method for estimating hourly averages of diffuse and direct solar radiation under a layer of scattered clouds, 2:41179
Preliminary study of the relationship between surface and bulk water temperatures at the Dresden cooling pond, 2:42000 (ANL—75-60(Pt.4), pp 64-68)
See Hicks, B.B., 2:42001, 2:42002, 2:42014
West, J.T., Evaluation of uncertainties in the gamma-ray heating analysis of a PWR, 2:41329 (CONF-770401—4)
West, J.T. III, Whitmarsh, C.L., Three-dimensional synthesis approach to reactor internal gamma-ray heating, 2:41328 (CONF-770401—3)
West, R.E., *See* Nannen, L.W., 2:41237
Westermeier, J.F., *See* Guter, G.A., 2:42016
Westmoreland, P.R., Pyrolysis of large coal blocks: implications of heat and mass transport effects for in situ gasification, 2:40798 (CONF-770301—13)
Weston, W.F., *See* Clark, A.F., 2:41885
Whaley, C.B., *See* Shifrine, M., 2:42039
Whitcher, R.E., Design of a high-pressure multi-kilowatt CO_2 laser, 2:41892 (AD-A—028234)
Whitcraft, M.S., *See* Smith, L.M., 2:40850
White, H.M., *See* Iura, T., 2:41711
White, J.W., *See* Miller, A., 2:42023
White, W.H., *See* Ogren, J.A., 2:41978, 2:41979, 2:41980, 2:41981, 2:41982
Whitelaw, R.L., *See* Warren, J.H., 2:41239
Whitlatch, E.E. Jr., Coal gasification in southeastern Ohio: water supply and demand. Completion report, 2:40789 (PB—254836)
Whitman, D.L., *See* Gunn, R.D., 2:40766
Wieber, P.R., 1976 ERDA in situ coal gasification program, 2:40746 (MERC/SP—76/3, pp 1-17)
Wier, C.E., Application of EREP imagery to fracture-related mine safety hazards in coal mining and mining-environmental problems in Indiana. Final report Apr 73—Apr 75, 2:40869 (E—76-10419)
Wiggins, D.S., Assessment of very high-temperature reactors in process applications. Appendix III. Engineering evaluation of process heat applications for very-high temperature reactors, 2:40788 (ORNL/TM—5411)
Wiggins, F.N., *See* Petit, G.S., 2:41887
Wikdahl, C.E., *See* Mandahl, B., 2:41121
Wilcox, J.M., Synoptic approach to sun—weather investigations, 2:42167 (N—76-29863)
Wilczek, J., *See* Hicks, B.B., 2:42002
Wilding, M.W., Iodine to control microbiological growth in fuel storage basin water, 2:41109 (ICP—1109)
Wilhelms, S.C., *See* Dortch, M.S., 2:41557
Wilker, M.I., *See* Barnett, C.F., 2:42231
Wilkes, G.R., *See* Michel, R.C., 2:41503
Wilkins, M.L., *See* Van Thiel, M., 2:41940
Willett, D.C., Underground pumped storage research priorities. Technical planning study, 2:41558 (PB—254413)
Williams, E.T., *See* Rundberg, R., 2:42201
Williams, F., *See* Thompson, P.N., 2:40775
Williams, J.E., Comparative life cycle costs, 2:41610 (NSF-RA—760006, pp 43-64)
Williams, J.J., *See* Wiggins, D.S., 2:40788
Williams, M.D., *See* Bartlit, J.R., 2:41499
Williams, M.L., Spatial channel theory: A technique for determining the directional flow of radiation through reactor systems, 2:41468 (CONF-770401—13)
Williams, R., *See* Eadie, G.G., 2:41996
Williams, T., *See* Fairchild, J.E., 2:41684
Wilson, A.C.M., Service performance of steam-turbine oils: oxidation stability and the predominant causes of service degradation, 2:41005
Wilson, C.D., *See* Andrews, S.C., 2:42009
Wilson, F.D., Hematopoietic effects, 2:42081 (UCD—472-123, pp 67-82)
See Shifrine, M., 2:42039
Wilson, J.C., *See* Sklarew, R.C., 2:41968
Wilson, J.E., Viscosity effects in the radiation-induced grafting of vinyl monomers on polyvinylchloride films. Technical report, 2:41878 (AD-A—026822)
Wilson, M.P. Jr., Spreading, retention and clean-up of oil spills. Final report, 2:40985 (COO—2756-1)
Wilson, N.H.M., *See* Meyer, M.B., 2:41709
Wilson, R.B., *See* Dantzig, G.B., 2:42331
Wilson, W., *See* Stanhouse, R.W., 2:41187
Wilson, W.E., Radiological physics and dosimetry research with a small positive ion accelerator, 2:42076 (BNWL-SA—5966)
Windmiller, L.R., *See* Arko, A.J., 2:41762
Windom, H.L., Trace element geochemistry of the South Atlantic Bight. Progress report, June 1, 1976—May 31, 1977, 2:42147 (SRO—890-2)
Winegartner, E.C., *See* Wagoner, C.L., 2:40910
Winkens, H.P., Thermoelectric power plants: a rational way of energy utilization in Europe, 2:41250
Winsor, N., *See* Basu, B., 2:42234
Winston, R., *See* Allen, J., 2:41231
Wirtz, R., *See* Domann, H., 2:41733
Wise, D.L., *See* Augenstein, D.C., 2:41169
Witten, A.J., *See* Adams, S.M., 2:41494
Wittenberg, L.J., Model for liquid uranium and plutonium with implications on the adjacent solid phases, 2:41777
Wittmann, H.G., *See* Hoppe, W., 2:42027
Wojciechowski, B.W., *See* Best, D.A., 2:40955
See Pachovsky, R.A., 2:40954, 2:40956
Wolf, D.A., *See* Bienert, W.B., 2:41201
Wolf, H.G., *See* Chrisp, C.E., 2:42089
Wolfensberger, A., *See* Hurter, T., 2:41286
Womach, J.D., *See* Grier, W.F., 2:40879
Wong, K.C., RF coupling and mode conversions at the lower hybrid resonance, 2:42269
Wong, M.J., *See* Buder, M.K., 2:40754
Wood, M.G., *See* Carstarphen, C., 2:41708
Woodall, J.M., *See* Hovel, H.J., 2:41186
Woods, M.D., *See* Novendstern, E.H., 2:41422
Woodyard, J.P., *See* Hathaway, S.A., 2:41174
Worcester, D.L., Neutron diffraction studies of biological membranes and membrane components, 2:42019 (BNL—50453, pp III.37-III.57)
Neutron diffraction studies of vertebrate striated muscle, 2:42024 (BNL—50453, pp III.101-III.114)
See Chabre, M., 2:42022
Worthington, B.M., *See* Shifrine, M., 2:42087

Wrenn, M.E., *See* Cohen, N., 2:42107
Wrona, B.J., Mechanical response of UO_2 subjected to transient heating, 2:41556
Wu, J.N.C., Thermal mechanical analysis procedure for a semicircular plate with clamped straight edge, 2:41474
Wu, P., *See* Taylor, R., 2:41897
Wu, Y.C.L., *See* Dicks, J.B., 2:41659
Wuerz, H., Use of neutron poisons for criticality safety in reprocessing plants, 2:41103
Wulff, G., *See* Duesing, G., 2:42297
Wuttke, G.H., *See* Henderson, T.M., 2:41151, 2:41153
Wyckoff, D.C., *See* Tate, V.H., 2:42164
Wynn, M.C., *See* Sheppard, J.D., 2:41534
Wynne, J.J., *See* Sorokin, P.P., 2:41912

Y

Yagi, E., Description of an engineering-scale facility for uranium fluorination studies, 2:41097 (JAERI-M—6487)
Technical experiences in an engineering-scale facility for uranium fluorination studies, 2:41098 (JAERI-M—6488)
Yakovlev, G.N., *See* Kapshukov, I.I., 2:41857
Yakovlev, V.A., *See* Gorchakov, Y.V., 2:42151
Yakovlev, V.I., *See* Proskulryakov, V.A., 2:41067
Yamada, M., Cross-field-current driven lower-hybrid instability and stochastic ion heating, 2:42216 (PPPL—1327)
Yamashita, Y., *See* Ouchi, K., 2:40842
Yamato, H., Basic plasma parameters of an experimental fusion reactor. First preliminary design, 2:42276 (JAERI-M—6484)
See Tone, T., 2:42285
Yaney, P.P., *See* Bass, M., 2:41894
Yanko, E.A., *See* Lazarev, V.D., 2:40829
Yano, Y., *See* Taniguchi, K., 2:42073
Yao, N.P., *See* Walsh, W.J., 2:41577
Yaroslavtsev, A.D., *See* Sycheva, A.M., 2:40944
Yates, L.M., *See* Erickson, R.E., 2:41972
Yavorsky, P.M., *See* Feldmann, H.F., 2:40792
Yeager, M.J., Neutron diffraction analysis of the structure of retinal photoreceptor membranes and rhodopsin, 2:42018 (BNL—50453, pp III.3-III.36)
Yeh, J.W., *See* Birss, E.W., 2:42339
Yeh, Y.C.M., *See* Stirn, R.J., 2:41191
Yerino, L.V., *See* Ponder, T.C. Jr, 2:41278
Yerkes, R.F., *See* Castle, R.O., 2:40937
Yocke, M.A., *See* Ogren, J.A., 2:41978, 2:41979, 2:41980, 2:41981, 2:41982
Yokokura, M., *See* Kuriyama, Y., 2:41049
Yonas, G., *See* Pashinin, P., 2:42220
York, T.M., Study of flow and loss processes at the ends of a linear theta pinch. Progress report for the period June 1, 1976—May 31, 1977, 2:42212 (COO—4020-3)
Yoshida, Y., Computer code for study of the error magnetic fields based on a model of practical poloidal field coils in a large tokamak, 2:42293 (JAERI-M—6470)
Yoshikawa, H., *See* Kikuchi, Y., 2:41527
Yoshioka, T., *See* Aoki, S., 2:41526
Young, C.W., *See* Werner, A.S., 2:40979
Young, J.E., Reaction kinetics of coal char gasification under conditions expected in underground coal gasification, 2:40776 (MERC/SP—76/3, pp 411-421)
Yudin, F.P, *See* Spitsyn, V.I., 2:41139
Yuhara, S., Creep and creep--rupture properties of 2^1_4Cr2Mo steel for fast breeder reactor in high temperature sodium, 2:41794
Yulikov, E.A., *See* Kondrat'ev, A.N., 2:41108
Yulin, M.K., *See* Gagarin, S.G., 2:40744
Yur'ev, G.S., *See* Filipchuk, I.G., 2:40822

Z

Zabramnyi, D.T., Use of brown coals after the extraction of the montan wax for the production of sulfomethyl derivatives, 2:40808
Zaccai, G., *See* Blasie, J.K., 2:42020
Zahradnik, J.W., Evaluation of proposed man-made ponds for food production to recover values in waste heat and solid organic sludges. Completion report, 2:41699 (PB—258773)
Zaidi, S.M.N., Experience from construction and operation of Karachi nuclear power plant, 2:41371 (IAEA-CN—36/547)
Zaimovskii, A.S., Plutonium fuel and fuel elements for power reactors, 2:41444 (IAEA-CN—36/353)
Zamanova, L.P., *See* Gagarin, S.G., 2:40744
Zanantoni, C., *See* Charrault, J.C., 2:41304
Zanghi, J.P., Melting-diffusion correlation in the plutonium-zirconium alloys, 2:41778
Zanker, A., Nomograph for viscosity calculation in binary mixtures, 2:41025
Zare, R.N., Determination of absolute photon yields in chemiluminescent reactions. Annual technical report, 3 Dec 1975—2 Dec 1976, 2:41872 (AD-A—034515)
Zaretsky, E.V., *See* Parker, R.J., 2:41010
Zarling, J.P., Laminar-flow pressure drop in symmetrical finite, rod bundles, 2:41464
Zelenskii, V.F., *See* Krasin, A.K., 2:41397
Zerby, C.D., Statement of C.D. Zerby before the California Energy Resources Conservation and Development Commission, Sacramento, California, March 21, 1977, 2:41143 (Y/OWI/TM—22)
Zharova, M.N., Raw materials resources for the production of brown-coal wax, 2:40806
Zhuravlev, V.I., *See* Bychev, M.I., 2:40826
Ziebland, H., *See* Beech, J.C., 2:41165
Zil'berbrandt, A.M., Thermal transformations of coals and some coal-graphite materials, 2:40800
See Karaseva, E.Z., 2:40818
Zilar, J.A., *See* Gant, R.G., 2:41506
Zimmerhackl, E., *See* Meier, H.U., 2:41664
Zinchenko, G.N., Study of the conditions necessary for the onset of mid-latitude spread F, 2:42185 (N—76-29782)
Zlotnik, E.Ya., Kinetic instability of a two-component plasma at gyrofrequency harmonics, 2:42255
Zoellner, G., *See* Goergen, H., 2:41284
Zolnierek, Z., Crystalline field and exchange interactions in the ternary uranium compounds of the U_2N_2M-type (M=P, As, S, Se), 2:41835
Zonn, M.S., Prospects of discovering oil and gas deposits in the jurassic complexes of west siberia, 2:40922
Zvegil'skii, D.S., *See* Bychev, M.I., 2:40826
Zvereva, G.A., *See* Baturov, B.B., 2:41358, 2:41449
Zwingelstein, G., Comparison of two adaptive identification methods for monitoring and diagnosis of an experimental nuclear reactor, 2:42335
Zytkow, A.N., *See* Thorne, K.S., 2:42152

SUBJECT INDEX

The subject index is based on the use of subject descriptors selected from a controlled thesaurus of terms. Subject descriptors and qualifiers (subheadings) are selected and presented in the following format:

SUBJECT DESCRIPTOR/QUALIFIER
Title, (supplementary information), citation number, (report number)

The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

Index entries are selected to indicate the important ideas and concepts presented in a document, rather than words that may appear in the text. Within the available thesaurus terms, the most probable or logical place to look for typical information is selected. "See references" are included to guide users from synonymous terms or phrases to the descriptor selected as a subject heading for the concept. (e.g. Pipeline Quality Gas see HIGH BTU GAS). "See also references" are used to indicate where to find references to subject concepts that are narrower, broader, or related to a particular subject heading. To complete an exhaustive search of a given subject, all such headings should be reviewed.

A

A-1 REACTOR (BOHUNICE)
See BOHUNICE A-1 REACTOR

ACETYLCHOLINE/BIOLOGICAL EFFECTS
Indomethacin induces rat uterine contractions in vitro and alters reactivity to calcium and acetylcholine, 2:42068

ACETYLSALICYLIC ACID/BIOLOGICAL EFFECTS
Indomethacin induces rat uterine contractions in vitro and alters reactivity to calcium and acetylcholine, 2:42068

ACID ELECTROLYTE FUEL CELLS/CATALYSTS
Investigation of acid-resistant electrocatalysts for fuel cells, 2:41664 (N-76-24724)

ACID ELECTROLYTE FUEL CELLS/ELECTROLYTES
Research on electrochemical energy conversion systems. Final technical report, 1 Jul 1975-30 Jun 1976 (Trifluoromethanesulfonic acid electrolyte), 2:41663 (AD-A-034454)

ACTINIDE ALLOYS/BINDING ENERGY
Metallurgical properties of metallic alloys in relation to their electronic structure: theoretical aspects and prospective for actinides, 2:41767

ACTINIDE ALLOYS/ELECTRONIC STRUCTURE
Effect of spin fluctuations in actinide systems, 2:41771
Metallurgical properties of metallic alloys in relation to their electronic structure: theoretical aspects and prospective for actinides, 2:41767

ACTINIDE ALLOYS/F STATES
Localized vs itinerant 5f electrons: a review of the experimental evidence, 2:41769

ACTINIDE ALLOYS/FORMATION FREE ENERGY
Metallurgical properties of metallic alloys in relation to their electronic structure: theoretical aspects and prospective for actinides, 2:41767

ACTINIDE ALLOYS/MAGNETIZATION
Magnetic ordering in the actinide intermetallics, 2:41804

ACTINIDE COMPOUNDS/ELECTRONIC STRUCTURE
Magnetic ordering and structural transformation in the actinide compounds, 2:41825

ACTINIDE COMPOUNDS/PHASE TRANSFORMATIONS
Magnetic ordering and structural transformation in the actinide compounds, 2:41825

ACTINIDE ISOTOPES/PERSONNEL MONITORING
Calibration techniques and error analysis for phoswich counting of actinide nuclides at Oak Ridge National Laboratory, 2:42096 (BNWL-2088)

ACTINIDE ISOTOPES/TISSUE DISTRIBUTION
Calibration techniques and error analysis for phoswich counting of actinide nuclides at Oak Ridge National Laboratory, 2:42096 (BNWL-2088)
Calibration techniques for the in vivo measurement of alpha-emitting actinides (In lungs), 2:42102 (BNWL-2088)
Estimation of lung and skeletal burdens of bone-seeking radionuclides in man from in vivo scintillation measurements of the thorax and the head, 2:42107 (BNWL-2088)
Present status of and future plans for ITRI's human and dog chest counting facilities, 2:42106 (BNWL-2088)

ADIABATIC TOROIDAL COMPRESSORS
See ATC DEVICES

ADSORBENTS/REGENERATION
Ways of reducing heat losses in the regeneration of alkali absorbents (Ammonia synthesis gas purification), 2:41173

AEROSOLS
See also RADIOACTIVE AEROSOLS

AEROSOLS/ENVIRONMENTAL TRANSPORT
Radiological and Environmental Research Division annual report. Part IV. Atmospheric physics. January-December 1975, 2:41950 (ANL-75-60(Pt.4))

AEROSOLS/HEALTH HAZARDS
Air pollution and the lung, 2:42127
Selection of animal models for evaluation of inhalation hazards in man, 2:42129

AEROSOLS/INHALATION
Selection of animal models for evaluation of inhalation hazards in man, 2:42129

AEROSOLS/LUNG CLEARANCE
Air pollution and the lung, 2:42127
Lung clearance of particles (TiO_2 tracer study), 2:42128

AEROSOLS/PARTICLE SIZE
Investigation of size-dependent concentration of trace elements in aerosols emitted from the oil-fired heating plants, 2:40986 (N-76-27720)

AGRICULTURE/INCOME
Strip mining in the corn belt: the destruction of high capability agricultural land for strip-minable coal in Illinois, 2:41642

AGRICULTURE/SOLAR ENERGY
Solar energy applications in agriculture: potential, research needs, and adoption strategies, summary and recommendations, 2:41217 (PB-255928)

AIR
See also EARTH ATMOSPHERE
SURFACE AIR

AIR/PHOTON TRANSPORT
FLAIR: a scaling and folding code for the generation of photon transport results in air. Final report, 2:42208 (AD-A-034754)

AIR CONDITIONERS
See also SOLAR AIR CONDITIONERS

AIR CONDITIONERS/MODIFICATIONS
Development of a solar powered residential air conditioner (general optimization). Final report, 2:41203 (N-76-24702)

AIR FILTERS/PERFORMANCE TESTING
Accelerated test for filter media exposure to fluoride environment, 2:41887 (K/TL-644)
Scanning electron microscope examination of samples from Herty Foundation in development of fluoride-resistant HEPA filter media (Fibermat and paper formulations using mixtures of asbestos fiber and Johns-Manville L-134 fibers), 2:41886 (K/TL-639)
AIR POLLUTION/AERIAL MONITORING
Structure of the urban moisture field (St. Louis urban area), 2:41957 (ANL-75-60(Pt.4))
AIR POLLUTION/EMISSION
Area source emission inventory: Hamilton County, Tennessee, and Walker and Catoosa Counties, Georgia. Volume I, 2:41973 (PB-258137)
Area source emission inventory: Hamilton County, Tennessee, and Walker and Catoosa Counties, Georgia. Volume II, 2:41974 (PB-258138)
AIR POLLUTION/ENVIRONMENTAL EFFECTS
Measurements of atmospheric turbidity in an arc downwind of St. Louis, 2:41955 (ANL-75-60(Pt.4))
AIR POLLUTION/ENVIRONMENTAL TRANSPORT
Puff-on-cell model for computing pollutant transport and diffusion, 2:41959 (ANL-75-60(Pt.4))
AIR POLLUTION/FORECASTING
Growth effects of major land use projects. Volume II. Compilation of land use based emission factors. Final report, 2:41997 (PB-255302)
AIR POLLUTION/INVENTORIES
Compilation of air pollutant emission factors. Supplement Number 6. Second edition, 2:41989 (PB-254274)
AIR POLLUTION/MATHEMATICAL MODELS
Hybrid computer program for rapidly solving flowing or static chemical kinetic problems involving many chemical species, 2:41963 (N-76-29382)
Meteorological adjustment of yearly mean values for air pollutant concentration comparison, 2:41964 (N-76-29738)
AIR POLLUTION/MONITORING
Source assessment: glass container manufacturing plants. Final report, Sep 1975-Sep 1976, 2:41977 (PB-262002)
AIR POLLUTION/OZONE
Determination of the feasibility of ozone formation in power plant plumes. Volume I. Executive summary, 2:41978 (PB-262092)
Determination of the feasibility of ozone formation in power plant plumes. Volume II. Final report, 2:41979 (PB-262093)
Determination of the feasibility of ozone formation in power plant plumes. Volume III. Data summary, 2:41980 (PB-262094)
Determination of the feasibility of ozone formation in power plant plumes. Volume IV. Data summary, 2:41981 (PB-262095)
Determination of the feasibility of ozone formation in power plant plumes. Volume V. Data summary, 2:41982 (PB-262096)
AIR POLLUTION/PHOTOCHEMICAL OXIDANTS
Utility of reactivity criteria in organic emission control strategies. Application to the Los Angeles atmosphere. Final report, 2:41971 (PB-257706)
AIR POLLUTION/REGIONAL ANALYSIS
PBL structure: the Sangamon Experiment of 1975 (Physical mechanisms for regional air pollution in Illinois), 2:41951 (ANL-75-60(Pt.4))
AIR POLLUTION CONTROL
Utility of reactivity criteria in organic emission control strategies. Application to the Los Angeles atmosphere. Final report, 2:41971 (PB-257706)
AIR POLLUTION CONTROL/FINANCING
Economic and financial impacts of federal air and water pollution controls on the electric utility industry. Executive summary. Final report, 2:41649 (PB-254307)
AIR POLLUTION CONTROL/POLLUTION CONTROL EQUIPMENT
Desulfurization of steel mill sinter plant gases. Final report, 2:41976 (PB-261922)
AIR POLLUTION MONITORS/GAS CHROMATOGRAPHY
Gas chromatographic analysis of air pollutants, 2:41985
AIR POLLUTION MONITORS/PERFORMANCE TESTING
Gas chromatographic analysis of air pollutants, 2:41985
Instrumental requirements for the measurement of pollutant fluxes (SO_2 and O_3 in surface air), 2:41960 (ANL-75-60(Pt.4))
AIR QUALITY/DATA
Area source emission inventory: Hamilton County, Tennessee, and Walker and Catoosa Counties, Georgia. Volume I, 2:41973 (PB-258137)
Area source emission inventory: Hamilton County, Tennessee, and Walker and Catoosa Counties, Georgia. Volume II, 2:41974 (PB-258138)
AIR QUALITY/MATHEMATICAL MODELS
Air quality models required data characterization. Final report, 2:41968 (PB-255730)
AIR QUALITY/STANDARDS
Guideline for public reporting of daily air quality: Pollutant Standards Index (PSI). Final report, 2:41992 (PB-257892)
AIRCRAFT/BLAST EFFECTS
NOVA-2: a digital computer program for analyzing nuclear overpressure effects on aircraft. Part 2. Computer program. Final report, 2:41943 (AD-A-029389)
AIRCRAFT/COMBUSTORS
Experimental clean combustor program, Phase 2, 2:41750 (N-76-28429)
AIRCRAFT/ECONOMICS
Study of short-haul aircraft operating economics. Phase 2: an analysis of the impact of jet modernization on local service airline operating costs. Final report, 2:41738 (N-76-29188)
AIRCRAFT/ENERGY CONSERVATION
Cost/benefit trade-offs for reducing the energy consumption of commercial air transportation (RECAT). Final report, 2:41605 (N-76-28203)
Cost/benefit trade-offs for reducing the energy consumption of commercial air transportation (RECAT). Summary report, 2:41606 (N-76-28204)
Effect of aircraft technology improvements on intercity energy use. Final report, 2:41608 (N-76-31090)
Study of cost/benefit tradeoffs for reducing the energy consumption of the commercial air transportation system (Advanced turboprop introduction), 2:41607 (N-76-31079)
AIRCRAFT/ENERGY CONSUMPTION
Study of cost/benefit tradeoffs for reducing the energy consumption of the commercial air transportation system (Advanced turboprop introduction), 2:41607 (N-76-31079)
Study of turbofan engines designed for low enery consumption, 2:41743 (N-76-30218)
AIRCRAFT/ENGINES
Study of turbofan engines designed for low enery consumption, 2:41743 (N-76-30218)
Study of unconventional aircraft engines designed for low energy consumption. Final report, 2:41742 (N-76-29233)
AIRCRAFT/EXHAUST GASES
Experimental clean combustor program, Phase 2, 2:41750 (N-76-28429)
AIRCRAFT/FEASIBILITY STUDIES
Cargo transportation by airships: a systems study. Final report, 2:41735 (N-76-27164)
AIRCRAFT/FUEL CONSUMPTION
Proposed flight simulator technology program. Study project report, 2:41680 (AD-A-028888)
Study of operational parameters impacting helicopter fuel consumption, 2:41736 (N-76-28224)
Study of unconventional aircraft engines designed for low energy consumption. Final report, 2:41742 (N-76-29233)
AIRCRAFT/FUEL ECONOMY
Study of the application of advanced technologies to laminar flow control systems for subsonic transports. Volume I. Summary. Final report, 2:41681 (N-76-24144)
Study of the application of advanced technologies to laminar-flow control systems for subsonic transports. Volume 2. Analyses. Final report, 2:41682 (N-76-24145)
AIRCRAFT/JET ENGINE FUELS
Potential of liquid hydrogen as a military aircraft fuel, 2:41753 (AD-A-026666)
AIRCRAFT/REGULATIONS
Report to Congress by the Federal Aviation Administration on the energy efficiency of agency regulations. Final report, 2:41632 (AD-A-034611)
AIRCRAFT FUELS
See AVIATION FUELS
AIRGLOW/EXCITATION
Response of the ionosphere to the injection of chemically reactive vapors, 2:42183 (N-76-28719)
ALASKA/EARTHQUAKES
Alaska Peninsula telemetered seismic network. Annual report, 2:42141 (RLO-2229-TC-3)
ALASKA/GEOTHERMAL EXPLORATION
Geothermal energy in the pacific region. Appendix A: exploration for a geothermal system in the Lualualei Valley, Oahu, Hawaii. Appendix B: exploration on Adak Island, Alaska, 2:41234 (AD-B-006305)
ALASKA/WATER QUALITY
Environmental quality profile, 1976. Alaska, Oregon, Idaho, Washington. Final report, 2:41990 (PB-255101)
ALASKA/WIND POWER
Wind power potential of Alaska. Part II. Wind duration curve fits and output power estimates for typical windmills, 2:41243 (RLO/2229/T12-76/1)
ALBERTA/RADIOACTIVE WASTE STORAGE
Radioactive waste management: model analysis of a proposed site, 2:41129

ALCOHOL FUEL CELLS/ELECTROLYTES
Research on electrochemical energy conversion systems. Final technical report, 1 Jul 1975-30 Jun 1976 (Trifluoromethanesulfonic acid electrolyte), 2:41663 (AD-A-034454)
ALCOHOLS
See also GLYCOLS
METHANOL
ALCOHOLS/FLAMMABILITY
Flammability limits: thermodynamics and kinetics. Final report, 2:41030 (PB-254180)
ALGAE
See also DIATOMS
ALGAE/BIOCHEMICAL REACTION KINETICS
Biological solar energy conversion: approaches to overcome yield, stability and product limitations. Progress report No. 3, 1 Apr 1976-30 Sep 1976, 2:41198 (PB-261910)
ALGAE/PHOTOSYNTHESIS
Biological solar energy conversion: approaches to overcome yield, stability and product limitations. Progress report No. 3, 1 Apr 1976-30 Sep 1976, 2:41198 (PB-261910)
ALKANES
See also BUTANE
ETHANE
METHANE
PARAFFIN
PROPANE
ALKANES/DISTRIBUTION
Laws of the distribution of normal and isoprenoid alkanes in coals of different ranks, 2:40832
ALKANES/FLAMMABILITY
Flammability limits: thermodynamics and kinetics. Final report, 2:41030 (PB-254180)
ALKANES/MOLECULAR STRUCTURE
Investigation of the group and component composition of the alcohol-benzene extract of the combustible shale of the boltysh deposit of the Ukrainian SSR, 2:41065
ALKENES
See also ETHYLENE
PROPYLENE
ALKENES/PRODUCTION
Operation of primary fractionation tower in unit for pyrolysis of liquid hydrocarbons, 2:40943
ALKENOIC ACIDS
See CARBOXYLIC ACIDS
ALLOYS/CORROSION
Sea water corrosion. Volume 1. 1964-1975 (a bibliography with abstracts). Report for 1964-1975, 2:41815 (NTIS/PS-77/0052)
ALPHA REACTIONS/ELASTIC SCATTERING
Energy dependence of the optical model parameters for α-particles scattered from ^{40}Ca and ^{58}Ni (< 85.6 MeV; differential cross sections), 2:42202
ALPHA REACTIONS/SPALLATION
Central collisions of relativistic heavy ions (250 to 2100-MeV/nucleon ^{20}Ne, 400-MeV/nucleon ^{4}He; light-particle energy spectra, differential cross sections), 2:42207
ALPHA SOURCES/RADIOISOTOPE SCANNING
Calibration techniques for the in vivo measurement of alpha-emitting actinides (In lungs), 2:42102 (BNWL-2088)
ALTERNATORS/ELECTRICAL FAULTS
Transient analysis of unbalanced short circuits of the ERDA-NASA 100-kW wind turbine alternator, 2:41244 (N-76-30650)
ALUMINATES/SPECTROSCOPY
Laser Raman spectrometric determination of oxy-anions in nuclear waste materials, 2:41868 (ARH-SA-279)
ALUMINIUM/ABSORPTION SPECTROSCOPY
Determination of trace metals in crude oils by nonflame atomic absorption spectroscopy, 2:41014
ALUMINIUM/MECHANICAL PROPERTIES
Semi-annual report on materials research in support of superconducting machinery. Final report (Composite materials), 2:41784 (PB-261996)
ALUMINIUM/NEUTRON REACTIONS
Calculations of the neutron emission spectra from materials bombarded with 14-mev neutrons, 2:42290
ALUMINIUM/PHYSICAL RADIATION EFFECTS
Fusion power program. Quarterly progress report, October-December 1976, 2:42314 (ANL/FPP-76-6)
ALUMINIUM/RADIOACTIVATION
Low activation materials assessment for fusion reactors, 2:42315 (EPRI-ER-328-SR)
ALUMINIUM/TENSILE PROPERTIES
Nonlinear analysis of laminated fibrous composites (Boron/epoxy, graphite/epoxy, borsic-aluminum), 2:41861 (N-76-27359)
ALUMINIUM/THERMAL CONDUCTIVITY
Semi-annual report on materials research in support of superconducting machinery. Final report (Composite materials), 2:41784 (PB-261996)
ALUMINIUM 26/COSMOCHEMISTRY
Cosmogenic radionuclides in stone meteorites, 2:42173 (N-76-25115)
ALUMINIUM ALLOYS
See also ALUMINIUM BASE ALLOYS
ALUMINIUM ALLOYS/FORGING
High-toughness titanium alloy development. Final engineering report Jan 1975-May 1976, 2:41756 (AD-A-030274)
ALUMINIUM ALLOYS/HEAT TREATMENTS
High-toughness titanium alloy development. Final engineering report Jan 1975-May 1976, 2:41756 (AD-A-030274)
ALUMINIUM ALLOYS/MECHANICAL PROPERTIES
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)
ALUMINIUM ALLOYS/MELTING
M551 metals melting experiment, 2:41757 (N-76-27401)
ALUMINIUM ALLOYS/MICROSTRUCTURE
M551 metals melting experiment, 2:41757 (N-76-27401)
ALUMINIUM ALLOYS/PHASE DIAGRAMS
Some results of a study of the Pu-Al-Ga phase diagram, 2:41765
ALUMINIUM ALLOYS/PHYSICAL RADIATION EFFECTS
Irradiation behaviour of UAlsub(x)-Al dispersion fuels for thermal high flux reactors, 2:41822
ALUMINIUM ALLOYS/RADIOACTIVATION
Low activation materials assessment for fusion reactors, 2:42315 (EPRI-ER-328-SR)
ALUMINIUM ALLOYS/THERMAL CONDUCTIVITY
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)
ALUMINIUM ALLOYS/VACUUM COATING
Coatings for directional eutectics. Final report (NiCrAlCy coating for NiTaC-13), 2:41814 (N-76-29370)
ALUMINIUM ALLOYS/WELDING
M551 metals melting experiment, 2:41757 (N-76-27401)
ALUMINIUM BASE ALLOYS/ELECTRONIC SPECIFIC HEAT
Calorimetric study of the intermetallic compounds UAl_2 and $PuAl_2$, 2:41807
ALUMINIUM BASE ALLOYS/MECHANICAL PROPERTIES
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)
ALUMINIUM BASE ALLOYS/THERMAL CONDUCTIVITY
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)
AMCHITKA ISLAND AREA/ECOLOGY
Ecology of intertidal benches of Amchitka Island, Alaska. Final summary report, August 1, 1974-December 31, 1974 (Dominance of sea otters), 2:41994 (RLO-2225-T36-1)
AMERICIUM/LATTICE VIBRATIONS
Role of lattice vibrations in the determination of the physical properties of the actinides, 2:41773
AMERICIUM/RADIOISOTOPE SCANNING
Preliminary evaluations of a high-purity germanium detector system for in vivo measurement of inhaled transuranium elements, 2:42113 (BNWL-2088)
AMERICIUM/TISSUE DISTRIBUTION
Preliminary evaluations of a high-purity germanium detector system for in vivo measurement of inhaled transuranium elements, 2:42113 (BNWL-2088)
AMERICIUM 241/BODY BURDEN
Measurement of transuranic elements in vivo at CRNL (Personnel monitoring at nuclear fuel fabrication plant), 2:42103 (BNWL-2088)
Proceedings of the workshop on measurement of heavy elements in vivo, 2:42093 (BNWL-2088)
AMERICIUM 241/INTERNAL IRRADIATION
Measurement of transuranic elements in vivo at CRNL (Personnel monitoring at nuclear fuel fabrication plant), 2:42103 (BNWL-2088)
AMERICIUM 241/PERSONNEL MONITORING
In vivo plutonium measurement at the Battelle-Northwest whole body center, 2:42104 (BNWL-2088)
AMERICIUM 241/RETENTION FUNCTIONS
In vivo plutonium measurement at the Battelle-Northwest whole body center, 2:42104 (BNWL-2088)
Methods for the assay of plutonium in vivo: what are the alternatives (^{238}Pu, ^{239}Pu, and ^{241}Am assay in vivo), 2:42108 (BNWL-2088)
AMERICIUM 241/SCINTILLATION COUNTING
Detection system for the localization and measurement in vivo of small amounts of photon emitters (Performance of Ge diode scintillation crystal-phototube system for personnel monitoring for ^{238}Pu, ^{239}Pu, and ^{241}Am), 2:42111 (BNWL-2088)
AMERICIUM 241/TISSUE DISTRIBUTION
Detection system for the localization and measurement in vivo of small amounts of photon emitters (Performance of Ge diode scintillation crystal-phototube system for personnel monitoring for ^{238}Pu, ^{239}Pu, and ^{241}Am), 2:42111 (BNWL-2088)
In vivo plutonium measurement at the Battelle-Northwest whole body center, 2:42104 (BNWL-2088)

LLL plutonium lung counter calibration and discussion of errors, 2:42105 (BNWL-2088)
AMERICIUM OXIDES/PHYSICAL RADIATION EFFECTS
Structural changes in actinide dioxides under self- and reactor irradiation, 2:41857
AMINES/CHROMATOGRAPHY
Naturally occurring nitrosatable amines. II. Secondary amines in tobacco and cigarette smoke condensate, 2:41867
AMINO ACIDS
See also PROLINE
AMINO ACIDS/EXCRETION
Aminoaciduria and proteinuria in rats after a single intraperitoneal injection of Ni(II), 2:42126
AMINOGLYCIDES
See AMINES
AMINOTRANSFERASES/GENETICS
Synteny between the Pro^+ marker and human glutamate oxaloacetate transaminase, 2:42044
AMMONIA/PRODUCTION
Economics of manufacturing synthesis gas produced by underground coal gasification, 2:40757 (MERC/SP-76/3)
AMMONIUM COMPOUNDS/LABELLING
Synthesis of ^{13}N- and ^{38}S-labeled fossil fuel power plant effluents for in vivo distribution studies, 2:42125 (UCD-472-123)
ANALGESICS
See also ACETYLSALICYLIC ACID
ANALGESICS/BIOLOGICAL EFFECTS
Contractility of rat testicular seminiferous tubules in vitro: prostaglandin F/sub lα/ and indomethacin, 2:42067
Indomethacin induces rat uterine contractions in vitro and alters reactivity to calcium and acetylcholine, 2:42068
ANDROGENS
See also TESTOSTERONE
ANDROGENS/BIOCHEMICAL REACTION KINETICS
Preliminary investigation of plasma sex hormone concentrations in normal and clinically abnormal male beagles, 2:42064 (UCD-472-123)
ANEMIAS
See also ISCHEMIA
ANEMIAS/RADIOINDUCTION
Pathology in a lifespan study of x-irradiated adult female beagles, 2:42079 (UCD-472-123)
ANIMAL CELLS
See also SPLEEN CELLS
TUMOR CELLS
ANIMAL CELLS/MUTANTS
Mutants of the Chinese hamster ovary cell line requiring analine and glutamate, 2:42047
ANIMAL FEEDS/BIOLOGICAL RADIATION EFFECTS
Beneficial Uses Program progress report, period ending December 31, 1976 (Gamma inactivation of microorganisms in sewage sludge), 2:42074 (SAND-77-0426)
ANL
(Argonne National Laboratory.)
ANL/COMPUTER CODES
Argonne Code Center: compilation of program abstracts, 2:42325 (ANL-7411(Suppl.10))
ANL/WASTE MANAGEMENT
Environmental monitoring at Argonne National Laboratory. Annual report for 1976, 2:41961 (ANL-77-13)
ANTHRACENE/HYDROCRACKING
Hydrocracking of polynuclear aromatic hydrocarbons over silica-alumina based dual functional catalysts, 2:40953
ANTHRACITE/ANISOTROPY
Anisotropy of anthracites from the results of a study of microhardness, 2:40825
ANTHRACITE/DENSITY
Question of the determination of the apparent density of brown and hard coals, 2:40820
ANTHRACITE/MICROHARDNESS
Anisotropy of anthracites from the results of a study of microhardness, 2:40825
ANTHRACITE/MOISTURE
Question of the determination of the apparent density of brown and hard coals, 2:40820
ANTHRACITE/STRUCTURAL CHEMICAL ANALYSIS
X-radiographic study of the structure of anthracite and its change on thermal treatment, 2:40822
ANTIBODY FORMATION/CONTROL
Control of IgE and IgGl antibody production in mice (X Radiation), 2:42082
ANTIGENS
Sufficient absorption: a quantitative method to replace exhaustive absorption, 2:42051
ANTIMONY/ACTIVATION ANALYSIS
Mode of occurrence of trace elements in petroleum and relationship to oil-spill identification methods, 2:41027
ANTIMONY/SPECTROPHOTOMETRY
Spectrophotometric determination of antimony in sebacate-base lubricants by the iodide method, 2:41008
ANTIMONY ALLOYS/CRYSTAL-PHASE TRANSFORMATIONS
Magnetic phase transitions in UO_2 and uranium compounds with crystal structures of Th_3P_4-type, 2:41780
ANTISERUM
See IMMUNE SERUMS
APARTMENT BUILDINGS/ENERGY CONSERVATION
Incentives for energy conservation in multi-family housing, 2:41674 (PB-255655)
APPARATUS
See EQUIPMENT
AQUACULTURE/TECHNOLOGY ASSESSMENT
Evaluation of proposed man-made ponds for food production to recover values in waste heat and solid organic sludges. Completion report, 2:41699 (PB-258773)
ARC WELDING/QUALITY ASSURANCE
How nuclear welding differs from other kinds, 2:41330 (CS-INIS-3)
ARCHITECTURE/REVIEWS
Use of earth covered buildings through history, 2:41588 (NSF-RA-760006)
ARCHITECTURE/UNDERGROUND
Terraset Elementary School, Reston, Virginia (Underground, solar-heated), 2:41616 (NSF-RA-760006)
University of Houston student center, 2:41615 (NSF-RA-760006)
Urban geotecture: the invisible features of the civic profile, 2:41589 (NSF-RA-760006)
ARCTIC REGIONS/COAL DEPOSITS
Sedimentary structures and paleocurrents in a tertiary deltaic succession, Northern Banks Basin, Arctic Canada, 2:40864
ARCTIC REGIONS/SEDIMENTARY ROCKS
Sedimentary structures and paleocurrents in a tertiary deltaic succession, Northern Banks Basin, Arctic Canada, 2:40864
ARGON/THERMAL CONDUCTIVITY
Shock tube study of the coefficient of thermal conductivity of helium, neon, argon and krypton, 2:42229 (INIS-mf-3404)
ARGONNE NATIONAL LABORATORY
See ANL
ARIZONA/INSOLATION
Solar microclimatology. Final report (Data for Arizona), 2:41233 (N-76-28738)
AROMATICS
See also BIPHENYL
CONDENSED AROMATICS
STYRENE
AROMATICS/MOLECULAR STRUCTURE
Investigation of the group and component composition of the alcohol-benzene extract of the combustible shale of the boltysh deposit of the Ukrainian SSR, 2:41065
AROMATICS/RESEARCH PROGRAMS
Petroleum derivatives. II. Current research, 2:40915
ARSENATES/CRYSTAL-PHASE TRANSFORMATIONS
Some actinides double orthovanadates and orthoarsenates: structural 'evolution' due to cationic and anionic substitutions, 2:41779
ARSENIC/ACTIVATION ANALYSIS
Mode of occurrence of trace elements in petroleum and relationship to oil-spill identification methods, 2:41027
ARSENIC/ENVIRONMENTAL TRANSPORT
Trace element geochemistry of the South Atlantic Bight. Progress report, June 1, 1976-May 31, 1977, 2:42147 (SRO-890-2)
ARSENIC COMPOUNDS/BIOLOGICAL EFFECTS
Review of the carcinogenicities of nickel, chromium, and arsenic compounds in man and animals, 2:42132
ARSONIUM COMPOUNDS
See ARSENIC COMPOUNDS
ASHES
See also FLY ASH
ASHES/LEACHING
Preliminary laboratory and modeling studies on the environmental impact of 'in-situ' coal gasification, 2:40753 (MERC/SP-76/3)
ASPHALTENES/ACTIVATION ANALYSIS
Mode of occurrence of trace elements in petroleum and relationship to oil-spill identification methods, 2:41027
ASPHALTENES/FLOCCULATION
Asphaltene flocculation during solvent stimulation of heavy oils, 2:40941
ASPHALTS
See also ASPHALTENES
ASPHALTS/INFRARED SPECTRA
Characterization of heavy residual fuel oils and asphalts by infrared spectrophotometry using statistical discriminant function analysis, 2:40994
ASPHALTS/REMOVAL
Deasphalt to get feed for lubes, 2:40950

ASPHALTS/SPECTROPHOTOMETRY
Characterization of heavy residual fuel oils and asphalts by infrared spectrophotometry using statistical discriminant function analysis, 2:40994
ASPIRIN
See ACETYLSALICYLIC ACID
ASTROCYTOMAS
See NEOPLASMS
ASTRONOMY/EXPERIMENT PLANNING
HEAO Block 2 study executive summary, 2:42159 (N-76-28123)
ATC DEVICES/PLASMA DRIFT
Free expansion experiment on ATC, 2:42218 (PPPL-1330)
ATHABASCA DEPOSIT/STRUCTURAL MODELS
Bitumen recovery from oil sands, using solvents in conjunction with steam, 2:41050
ATLANTIC OCEAN
See also NORTH SEA
ATLANTIC OCEAN/CONTINENTAL SHELF
Trace element geochemistry of the South Atlantic Bight. Progress report, June 1, 1976-May 31, 1977, 2:42147 (SRO-890-2)
ATLANTIC OCEAN/OCEANOGRAPHY
Trace element geochemistry of the South Atlantic Bight. Progress report, June 1, 1976-May 31, 1977, 2:42147 (SRO-890-2)
ATOM-ATOM COLLISIONS/DATA COMPILATION
Atomic data for controlled fusion research, 2:42231 (ORNL-5206(Vol.1))
ATOMIC BOMBS
See NUCLEAR WEAPONS
ATOMIC EXPLOSIONS
See NUCLEAR EXPLOSIONS
ATOMIC WEAPONS
See NUCLEAR WEAPONS
AURORAE/DATA
Report on the geophysical description and available data associated with rocket PF-NH-89 (IC 507.11-2a), 2:42189 (AD-A-034731)
AURORAL SUBSTORMS
See MAGNETIC BAYS
AUSTRALIA/COAL GASIFICATION
In-situ gasification in Australia: prospects, potential, and research activities, 2:40774 (MERC/SP-76/3)
AUSTRALIA/FEED MATERIALS PLANTS
Management of wastes containing radioactivity from mining and milling of uranium ores in Northern Australia, 2:41124 (IAEA-CN-36/418)
AUSTRALIA/URANIUM MINES
Management of wastes containing radioactivity from mining and milling of uranium ores in Northern Australia, 2:41124 (IAEA-CN-36/418)
AUTOMOBILES
Public attitudes and behavior regarding energy conservation: detailed tabulations by U.S. population segments; Waves 3 and 4. Monthly tabulated report, 2:41622 (PB-254591)
AUTOMOBILES/ECONOMICS
Automotive industry in 1974: an international survey. International economics report 1972-1974, 2:41700 (PB-254945)
AUTOMOBILES/FUEL ECONOMY
Research plan for achieving reduced automotive energy consumption, 2:41711 (PB-255929)
AUTOMOBILES/RANKINE CYCLE ENGINES
Assessment of the technology of Rankine engines for automobiles, 2:41726 (ERDA-77-54)
AUTOMOBILES/STRATIFIED CHARGE ENGINES
Study of stratified charge for light duty power plants. Volume I. Final report, 2:41716 (PB-256220)
Study of stratified charge for light duty power plants: Volume 3. Executive summary. Final report, 2:41717 (PB-256221)
AUTOMOBILES/USES
Effect of energy shortage and land use on automobile occupancy rate. Research report, 2:41685 (PB-254921)
AUTOMOTIVE FUELS
See also HYDROGEN FUELS
Research and development of rapid hydrogenation for coal conversion to synthetic motor fuels (Riser Cracking of Coal). Third Quarter Report, October 1-December 31, 1976, 2:40794 (FE-2307-13)
AUXILIARY WATER SYSTEMS
See also CONDENSER COOLING SYSTEMS
AUXILIARY WATER SYSTEMS/PUMPS
Feed and condensate pumps in nuclear power stations (BWR; PWR), 2:41322 (SIGLUT-P-719)
AVIATION FUELS
See also HYDROGEN FUELS
AVIATION FUELS/CHEMICAL COMPOSITION
Aviation turbine fuels, 1976, 2:40998 (BERC/PPS-77/2)
AVIATION FUELS/CONSUMPTION RATES
Report to Congress by the Federal Aviation Administration on the energy efficiency of agency regulations. Final report, 2:41632 (AD-A-034611)
AVIATION FUELS/PHYSICAL PROPERTIES
Aviation turbine fuels, 1976, 2:40998 (BERC/PPS-77/2)
AXONS
See NERVE CELLS
AZIDES/MUTAGENESIS
Increasing the efficiency of azide mutagenesis in barley, 2:42043 (RLO-2221-T2-31)

B

BACILLUS SUBTILIS/METABOLISM
Bacillus subtilis deoxyuridinetriphosphatase and its bacteriophage PBS2-induced inhibitor, 2:42055
BACTERIA
See also HAEMOPHILUS
PNEUMOCOCCUS
BACTERIA/ECOLOGY
Decomposition in freshwater, 2:42004
BACTERIA/INACTIVATION
Microbiological corrosion of tanks in long-term storage of gas oil. II. Further bacterial studies and use of borax as a biocide, 2:41029
BACTERIA/LETHAL IRRADIATION
Beneficial Uses Program progress report, period ending December 31, 1976 (Gamma inactivation of microorganisms in sewage sludge), 2:42074 (SAND-77-0426)
BACTERIA/METABOLISM
Microbiological corrosion of tanks in long-term storage of gas oil, 2:41028
BACTERIA/PHOTOSYNTHESIS
Investigation of the structure of the reaction center in photosynthetic bacteria by optical detection of triplet state magnetic resonance, 2:42035
BACTERIOPHAGES/METABOLISM
Bacillus subtilis deoxyuridinetriphosphatase and its bacteriophage PBS2-induced inhibitor, 2:42055
BACTERIOPHAGES/MUTATIONS
Studies of temperature sensitive mutants of bacteriophage Qβ, defective in both replication and translation, 2:42045
BAFFLED TUBES/STRESS ANALYSIS
Thermal mechanical analysis procedure for a semicircular plate with clamped straight edge (U-tube steam generator divider plate), 2:41474
BARIUM/CHEMICAL REACTIONS
Determination of absolute photon yields in chemiluminescent reactions. Annual technical report, 3 Dec 1975-2 Dec 1976, 2:41872 (AD-A-034515)
BARLEY/BIOLOGICAL EFFECTS
Increasing the efficiency of azide mutagenesis in barley, 2:42043 (RLO-2221-T2-31)
BARLEY/MUTAGENESIS
Increasing the efficiency of azide mutagenesis in barley, 2:42043 (RLO-2221-T2-31)
BASES/EXHAUST GASES
Development and operational validation of a transit bus simulation. Final research report, 2:41684 (PB-254891)
BASES/FUEL CONSUMPTION
Development and operational validation of a transit bus simulation. Final research report, 2:41684 (PB-254891)
BASES/PERFORMANCE TESTING
Development and operational validation of a transit bus simulation. Final research report, 2:41684 (PB-254891)
BATTERIES (ELECTRIC)
See ELECTRIC BATTERIES
BEAGLES/ANDROGENS
Preliminary investigation of plasma sex hormone concentrations in normal and clinically abnormal male beagles, 2:42064 (UCD-472-123)
BEAGLES/BIOLOGICAL RADIATION EFFECTS
Clinical case load for radionuclide-treated beagles, calendar year 1975, 2:42088 (UCD-472-123)
Cumulative mortality in radionuclide treated beagles, 2:42089 (UCD-472-123)
Pathology in a lifespan study of x-irradiated adult female beagles, 2:42079 (UCD-472-123)
BEAGLES/RADIONUCLIDE KINETICS
Canine bone dynamics, 2:42090 (UCD-472-123)
BEAM MONITORS/FEASIBILITY STUDIES
Carbon ribbon gauge for electron beam diagnostics. Final report, 2:41926 (AD-A-026905)
BEAM MONITORS/PERFORMANCE
Faraday cup with multiple internal filters and a primary current monitor for characterizing high dose pulsed electron beams. Final report, 2:41924 (AD-A-034613)

BEAM-PLASMA SYSTEMS/PLASMA SIMULATION
Limitations on the radical acceleration of a plasma formed by an intense relativistic electron beam, 2:42242
BEAM-PLASMA SYSTEMS/PLASMA WAVES
Investigations of low-frequency oscillations and ion acceleration in a plasma beam discharge, 2:42256
BEARINGS/PERFORMANCE
Bearing application of quick running rotors, particularly of waste gas superchargers (Patent), 2:41882
BELGIUM/RADIOACTIVE WASTE MANAGEMENT
Radioactive waste management in Belgium, 2:41117 (IAEA-CN-36/187)
BELOYARSK-2 REACTOR/PERFORMANCE
Nuclear steam superheat results and current prospects, 2:41358 (IAEA-CN-36/325)
BERYLLIUM/ABSORPTION SPECTROSCOPY
Novel wet-digestion procedure for trace-metal analysis of coal by atomic absorption, 2:40836
BERYLLIUM 9 TARGET/NEUTRON REACTIONS
Cross section for the $^{9}Be(n,t_1)^{7}Li$ reaction between 13.3 and 15 MeV, 2:42200
BERYLLIUM MODERATORS
See BERYLLIUM
BIBLIS-A REACTOR/CONSTRUCTION
Nuclear power plant at Biblis, 2:41337
BINARY STARS/COSMIC X-RAY SOURCES
All-Sky Monitor observations of the decay of A0620-00 (Nova Monocerotis 1975), 2:42158 (N-76-28120)
BIOMASS
(All growing organic matter such as plants, trees, grasses, and algae.)
BIOMASS/COMBUSTION
Feasibility of meeting the energy needs of army bases with self-generated fuels derived from solar energy plantations. Final report, 2:41196 (AD-A-031163)
Feasibility of meeting the energy needs of army bases with self-generated fuels derived from solar energy plantations (Appendices D, E, F, G, and H). Final report, 2:41197 (AD-A-031211)
BIOMASS/RESEARCH PROGRAMS
Federal fuels from biomass energy program, 2:41166
BIOMASS PLANTATIONS/FEASIBILITY STUDIES
Feasibility of meeting the energy needs of army bases with self-generated fuels derived from solar energy plantations. Final report, 2:41196 (AD-A-031163)
Feasibility of meeting the energy needs of army bases with self-generated fuels derived from solar energy plantations (Appendices D, E, F, G, and H). Final report, 2:41197 (AD-A-031211)
BIOPHYSICS
Neutron scattering by collagen, 2:42023 (BNL-50453)
BIPHENYL/AEROSOL MONITORING
Gas chromatographic analysis of air pollutants, 2:41985
BISMUTH ALLOYS/CRYSTAL-PHASE TRANSFORMATIONS
Magnetic phase transitions in UO_2 and uranium compounds with crystal structures of Th_3P_4-type, 2:41780
BITUMENS
See also ASPHALTS
COAL TAR
BITUMENS/CATALYTIC CRACKING
Hydrocracking of residual oils and tars. II. The catalytic hydrocracking of Athabasca bitumen, 2:41060
Hydrocracking of residual oils and tars. IV. Catalyst de-activation with bitumens from Athabasca, Cold Lake, and Lloydminster, 2:41062
BITUMENS/CHEMICAL COMPOSITION
Investigations of the bitumens of solid fuels under the electron microscope, 2:40807
Investigation of the composition and possible methods of using extracts of tertiary brown coals of the Southern Urals Basin, 2:40809
BITUMENS/CHEMICAL PROPERTIES
Investigation of the composition and possible methods of using extracts of tertiary brown coals of the Southern Urals Basin, 2:40809
BITUMENS/DESULFURIZATION
Hydrocracking of residual oils and tars. V. Surface-coated cobalt molybdate catalysts for hydro-treating, 2:41063
BITUMENS/EXTRACTION
Investigation of the composition and possible methods of using extracts of tertiary brown coals of the Southern Urals Basin, 2:40809
BITUMENS/HYDROCRACKING
Hydrocracking of residual oils and tars. I. The effect of feed dilution on the thermal hydrocracking of Athabasca bitumen, 2:41059
Hydrocracking of residual oils and tars. II. The catalytic hydrocracking of Athabasca bitumen, 2:41060
Hydrocracking of residual oils and tars. III. The effect of mineral matter on the thermal and catalytic hydrocracking of Athabasca bitumen, 2:41061
Hydrocracking of residual oils and tars. IV. Catalyst de-activation with bitumens from Athabasca, Cold Lake, and Lloydminster, 2:41062
Hydrocracking of residual oils and tars. V. Surface-coated cobalt molybdate catalysts for hydro-treating, 2:41063
Some observations on the hydroprocessing of a heavy crude oil, 2:41064
BITUMENS/MOLECULAR STRUCTURE
Investigations of the bitumens of solid fuels under the electron microscope, 2:40807
Investigation of the group and component composition of the alcohol-benzene extract of the combustible shale of the boltysh deposit of the Ukrainian SSR, 2:41065
BITUMENS/PHYSICAL PROPERTIES
Investigations of the bitumens of solid fuels under the electron microscope, 2:40807
BITUMENS/PROCESSING
Chemistry of petroleum processing and extraction. II, 2:40949
BITUMENS/RECOVERY
Bitumen recovery from oil sands, using solvents in conjunction with steam, 2:41050
BITUMENS/SOLVENT EXTRACTION
Investigation of the group and component composition of the alcohol-benzene extract of the combustible shale of the boltysh deposit of the Ukrainian SSR, 2:41065
BITUMENS/STRUCTURAL CHEMICAL ANALYSIS
Investigations of the bitumens of solid fuels under the electron microscope, 2:40807
BITUMENS/THERMAL CRACKING
Hydrocracking of residual oils and tars. III. The effect of mineral matter on the thermal and catalytic hydrocracking of Athabasca bitumen, 2:41061
BITUMINOUS COAL/CAKING POWER
Active radicals containing oxygen and caking property of lignite, 2:40848
BITUMINOUS COAL/SURFACE MINING
Strip mining in the corn belt: the destruction of high capability agricultural land for strip-minable coal in Illinois, 2:41642
BITUMINOUS COAL/THERMAL CONDUCTIVITY
Real mass and energy transport coefficients determined from UCG process simulation experiments (Temperature dependence), 2:40786 (MERC/SP-76/3)
BITUMINOUS COAL/THERMAL DIFFUSIVITY
Real mass and energy transport coefficients determined from UCG process simulation experiments (Temperature dependence), 2:40786 (MERC/SP-76/3)
BLANKETS (BREEDING)
See BREEDING BLANKETS
BLOOD FLOW/MEASURING METHODS
Quantitation of ischemic and infarcted myocardium: relation between 99 Tc pyrophosphate and regional and total coronary blood flow, myocardial function and metabolism. Annual scientific report, 1 Jul 1975-31 Mar 1976, 2:42060 (PB-262160)
BLOOD FORMATION
See also ERYTHROPOIESIS
BLOOD FORMATION/BIOLOGICAL RADIATION EFFECTS
Inhibition of erythroid cell growth in irradiated mice by allogeneic lymphoid cells: specificity of the response (X Radiation), 2:42071
BLOWDOWN/MATHEMATICAL MODELS
Effects of modeling variations on RELAP4. predictions of Standard Problem Five (BWR;PWR), 2:41544
BLOWDOWN/RESEARCH PROGRAMS
BWR blowdown/emergency core cooling third quarterly progress report, July 1-September 30, 1976, 2:41511 (GEAP-21304-3)
BLOWDOWN/TWO-PHASE FLOW
Quarterly progress report on advanced two-phase instrumentation program for November-December 1976, 2:41534 (ORNL/NUREG/TM-93)
BNPS-2 REACTOR
See BELOYARSK-2 REACTOR
BOHUNICE A-1 REACTOR/BLOWERS
In-service inspection and diagnostics of A-1 power plant blowers, 2:41373 (INIS-mf-3389)
BOHUNICE A-1 REACTOR/PRESSURE VESSELS
Preparing periodic inspections of A-1 reactor pressure vessel, 2:41372 (INIS-mf-3389)
Thermal strain effect of welding on the properties and stress state of welded joints in the pressure vessel of the A 1 reactor, 2:41374 (VR-688/76)
BOILERS/AIR POLLUTION CONTROL
Prevention of dust pollution from boilers, 2:41281
BOILERS/DESIGN
Coal power and combustion. Quarterly report, April-June 1976, 2:40907 (ERDA-76-94/2)

Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
Generator boilers, 2:41669
BOILERS/FUEL CONSUMPTION
Device for saving fuel and cleaning off-gas in heating installations (Patent), 2:41282
BOILERS/POLLUTION CONTROL EQUIPMENT
Device for saving fuel and cleaning off-gas in heating installations (Patent), 2:41282
BOILING WATER REACTORS
See BWR TYPE REACTORS
BOLTZMANN COLLISION INTEGRAL
See BOLTZMANN EQUATION
BOLTZMANN EQUATION
Electron Boltzmann equation in a plasma generated by fission fragments, 2:42195 (N-76-29018)
BOLTZMANN TRANSPORT EQUATION
See BOLTZMANN EQUATION
BONE MARROW CELLS/CELL PROLIFERATION
Lymphoid colonies (Cell cultures on methylcellulose culture system), 2:42039 (UCD-472-123)
BONE MARROW CELLS/ERYTHROPOIESIS
Study of haemopoietic microenvironment in vitro, 2:42070
BONE TISSUES/RADIOISOTOPE SCANNING
Estimation of lung and skeletal burdens of bone-seeking radionuclides in man from in vivo scintillation measurements of the thorax and the head, 2:42107 (BNWL-2088)
BOREHOLES/COVERINGS
Design schemes of small diameter drillings in coal deposits, 2:40890
BOREHOLES/PRESSURE MEASUREMENT
Method of determination of abnormally high formation pressures from the data of geophysical investigations of boreholes, 2:40926
BOREHOLES/RESISTIVITY LOGGING
Comparison of sounding results and their interpretation in the absence of borehole control, 2:42143
BOREHOLES/TEMPERATURE MEASUREMENT
On shallow-hole temperature measurements--a test study in the Salton Sea geothermal field, 2:41236 (PB-262643)
BORN-GREEN-YVON EQUATION
See BOLTZMANN EQUATION
BORON/MECHANICAL PROPERTIES
Advanced composites: mechanical properties and hardware programs for selected resin matrix materials (Boron and graphite fiber reinforcement), 2:41860 (N-76-24364)
Semi-annual report on materials research in support of superconducting machinery. Final report (Composite materials), 2:41784 (PB-261996)
BORON/TENSILE PROPERTIES
Nonlinear analysis of laminated fibrous composites (Boron/epoxy, graphite/epoxy, borsic-aluminum), 2:41861 (N-76-27359)
BORON/THERMAL CONDUCTIVITY
Semi-annual report on materials research in support of superconducting machinery. Final report (Composite materials), 2:41784 (PB-261996)
BOUNDARY LAYERS/DAILY VARIATIONS
PBL scaling using surface flux information (Scales of similarity theory for the planetary boundary layer), 2:41953 (ANL-75-60(Pt.4))
Preliminary look at the diurnal behavior of the PBL (Environmental transport of air pollutants), 2:41952 (ANL-75-60(Pt.4))
BOUNDARY LAYERS/MIXING
Generalized Kolmogorov-von Karman relation and some further implications on the magnitude of the constants (Effects of wind sheer on atmospheric surface boundary layer), 2:41949 (ANL-75-60(Pt.4))
BRAYTON CYCLE POWER SYSTEMS/DESIGN
Nuclear powered satellite design for shuttle launches, 2:41157
BREEDER REACTORS
See also FBR TYPE REACTORS
GCFR TYPE REACTORS
LMFBR TYPE REACTORS
BREEDER REACTORS/PLANNING
Status and prospects of thermal breeders, 2:41395 (IAEA-CN-36/302)
BREEDER REACTORS/USES
Consequences of the energy crisis, 2:41631
BREEDING BLANKETS/PERFORMANCE TESTING
Radial blanket design and development. Quarterly progress report for period ending May 31, 1976 (LMFBR), 2:41409 (WARD-RB-3045-14)
BREEDING BLANKETS/RESEARCH PROGRAMS
Radial blanket design and development. Quarterly progress report for period ending May 31, 1976 (LMFBR), 2:41409 (WARD-RB-3045-14)
BRINES/CHEMICAL ANALYSIS
Iodine in oil and gas fields: especially on the geochemical consideration of the prospecting for iodine deposits, 2:42145 (N-76-27750)
BRINES/GEOCHEMISTRY
Materials problems associated with the development of geothermal energy resources, 2:41240 (PB-254990)
BROWN COAL/BY-PRODUCTS
Compound isolation from brown coal by low-temperature evacuation, 2:40847
BROWN COAL/CARBONIZATION
Changes in state of combination of inorganic constituents during carbonization of Victorian brown coal, 2:40737
BROWN COAL/COMBUSTION PROPERTIES
Study of the fire risk of brown coals of the Kharanorskoe deposit, 2:40821
BROWN COAL/DENSITY
Question of the determination of the apparent density of brown and hard coals, 2:40820
BROWN COAL/MOISTURE
Question of the determination of the apparent density of brown and hard coals, 2:40820
BROWN COAL/OXIDATION
Compound isolation from brown coal by low-temperature evacuation, 2:40847
BUILDINGS
See also APARTMENT BUILDINGS
GREENHOUSES
HOSPITALS
HOUSES
OFFICE BUILDINGS
SCHOOL BUILDINGS
BUILDINGS/ENERGY CONSERVATION
Controlled heat from the floor. Electric floor heating accumulates heat in the concrete floor, 2:41672
New energy economics and the role of energy conservation in buildings, 2:41611 (NSF-RA-760006)
BUILDINGS/ENERGY CONSUMPTION
Comparison of energy consumption in earth-covered vs. non-earth-covered buildings, 2:41612 (NSF-RA-760006)
New energy economics and the role of energy conservation in buildings, 2:41611 (NSF-RA-760006)
Strategies for legislative change (To encourage earth-covered construction), 2:41633 (NSF-RA-760006)
BUILDINGS/ENVIRONMENTAL IMPACTS
Build without destroying the Earth, 2:41592 (NSF-RA-760006)
Earth-covered buildings and environmental impact, 2:41595 (NSF-RA-760006)
BUILDINGS/GEOTHERMAL SPACE HEATING
Investigation of the technical and economical feasibility of using low temperature geothermal sources in Colorado, 2:41237
BUILDINGS/HEAT RECOVERY
Liquid coupled system for heat recovery from exhaust gases, 2:41670
BUILDINGS/LIFE-CYCLE COST
Comparative life cycle costs (Earth-covered buildings), 2:41610 (NSF-RA-760006)
BUILDINGS/MEETINGS
Alternatives in energy conservation: the use of earth covered buildings (Conference; about 525 references), 2:41609 (NSF-RA-760006)
BUILDINGS/SPACE HEATING
Controlled heat from the floor. Electric floor heating accumulates heat in the concrete floor, 2:41672
BUILDINGS/UNDERGROUND
Air quality and heat transfer (Earth-covered construction), 2:41593 (NSF-RA-760006)
Alternative to suburbia, 2:41591 (NSF-RA-760006)
Alternatives in energy conservation: the use of earth covered buildings (Conference; about 525 references), 2:41609 (NSF-RA-760006)
Comparative life cycle costs (Earth-covered buildings), 2:41610 (NSF-RA-760006)
Earth-covered buildings and environmental impact, 2:41595 (NSF-RA-760006)
Effect of ground cover on Earth temperature, 2:41596 (NSF-RA-760006)
Psychology of earth-covered buildings, 2:41585 (NSF-RA-760006)
Soil and ground water considerations (Earth-covered construction), 2:41594 (NSF-RA-760006)
Strategies for legislative change (To encourage earth-covered construction), 2:41633 (NSF-RA-760006)
Urban geotecture: the invisible features of the civic profile, 2:41589 (NSF-RA-760006)
Use of earth covered buildings through history, 2:41588 (NSF-RA-760006)
BUILDINGS (CONTAINMENT)
See CONTAINMENT BUILDINGS

BUNKER OILS
See RESIDUAL FUELS
BURST CAN MONITORS
See FAILED ELEMENT MONITORS
BURST SLUG MONITORS
See FAILED ELEMENT MONITORS
BUSES/FUEL ECONOMY
Research plan for achieving reduced automotive energy consumption, 2:41711 (PB-255929)
BUSES/LIFE-CYCLE COST
Life cycle costing for current Rohr and AM general buses and General Motors RTS-II bus. Final report, Mar 1976-Jul 1976, 2:41715 (PB-255091)
BUSES/OPERATION
Bus priority system simulator (Traffic signal system giving priority to buses), 2:41706
BUTANE/OXIDATION
Research on electrochemical energy conversion systems. Final technical report, 1 Jul 1975-30 Jun 1976 (Trifluoromethanesulfonic acid electrolyte), 2:41663 (AD-A-034454)
BWR TYPE REACTORS
See also GE STANDARD REACTOR
MILLSTONE-1 REACTOR
MONTICELLO REACTOR
PEACH BOTTOM-2 REACTOR
PEACH BOTTOM-3 REACTOR
PHILIPPSBURG-1 REACTOR
QUAD CITIES-1 REACTOR
QUAD CITIES-2 REACTOR
TARAPUR-1 REACTOR
VERMONT YANKEE REACTOR
BWR TYPE REACTORS/AUXILIARY WATER SYSTEMS
Feed and condensate pumps in nuclear power stations, 2:41322 (SIGLUT-P-719)
BWR TYPE REACTORS/BLOWDOWN
BWR blowdown/emergency core cooling third quarterly progress report, July 1-September 30, 1976, 2:41511 (GEAP-21304-3)
Effects of modeling variations on RELAP4. predictions of Standard Problem Five, 2:41544
BWR TYPE REACTORS/CONTAINMENT SYSTEMS
Reactor containment analysis for BWR suppression systems. Progress report, October-December 1976, 2:41538 (UCRL-50045-76-4)
BWR TYPE REACTORS/CORE FLOODING SYSTEMS
Prediction of reflood heat transfer with standard loop programs, 2:41553
BWR TYPE REACTORS/ECCS
BWR blowdown/emergency core cooling third quarterly progress report, July 1-September 30, 1976, 2:41511 (GEAP-21304-3)
BWR TYPE REACTORS/ECONOMICS
Arguments for the installation of small LWR nuclear power plants in developing countries, 2:41315 (IAEA-CN-36/89)
BWR TYPE REACTORS/FUEL CYCLE
PWR and BWR light water reactor systems in the USA and their fuel cycle, 2:41319 (IAEA-CN-36/566)
BWR TYPE REACTORS/FUEL ELEMENT FAILURE
Experimental investigations of the power ramp failure propensity of LWR fuel, 2:41520 (IAEA-CN-36/279)
BWR TYPE REACTORS/FUEL ELEMENTS
Fuel reliability in light water reactors, experience and assessment for the future, 2:41316 (IAEA-CN-36/474)
Italian progress on LWR fuel design, manufacturing, testing and management, 2:41331 (IAEA-CN-36/310)
Performance and reliability of LWR fuel, 2:41317 (IAEA-CN-36/475)
BWR TYPE REACTORS/LOOSE PARTS MONITORING
Noise diagnostics for safety assessment. Quarterly progress report for October-December 1976, 2:41321 (ORNL/NUREG/TM-97)
BWR TYPE REACTORS/LOSS OF COOLANT
Analysis of loss of coolant accidents, 2:41515 (IAEA-CN-36/127)
BWR blowdown/emergency core cooling third quarterly progress report, July 1-September 30, 1976, 2:41511 (GEAP-21304-3)
BWR TYPE REACTORS/MELTDOWN
Properties of light water reactor core melts, 2:41555
BWR TYPE REACTORS/OFF-GAS SYSTEMS
Nuclear off-gas treatment...the cryogenic distillation method, 2:41323
BWR TYPE REACTORS/PLUTONIUM RECYCLE
Experience with Pu-recycle fuel for large light water reactors in the Federal Republic of Germany, 2:41318 (IAEA-CN-36/558)
Pu utilization in fast-breeder and in light-water reactors in Italy, 2:41320 (IAEA-CN-36/577)
BWR TYPE REACTORS/PRESSURE VESSELS
Development of an integrated prestressed concrete vessel for water cooled reactors, 2:41324
Study of radiation dosage to structural components in nuclear reactors. Final report, 2:41536 (PB-257567)
BWR TYPE REACTORS/PRIMARY COOLANT CIRCUITS
Summary on experimental methods for statistical transient analysis of two-phase gas-liquid flow, 2:41312 (ANL-76-75)
BWR TYPE REACTORS/RADIOACTIVE WASTE PROCESSING
Role of volume reduction processes in LWR radwaste treatment, 2:41326
Thin-film evaporators for processing BWR liquid radwaste, 2:41325
BWR TYPE REACTORS/REACTOR INTERNALS
Study of radiation dosage to structural components in nuclear reactors. Final report, 2:41536 (PB-257567)
BWR TYPE REACTORS/REACTOR OPERATION
PWR and BWR light water reactor systems in the USA and their fuel cycle, 2:41319 (IAEA-CN-36/566)
Safety aspects and operating experience of LWR plants in Japan, 2:41526 (IAEA-CN-36/544)
BWR TYPE REACTORS/REACTOR SAFETY
BWR blowdown/emergency core cooling third quarterly progress report, July 1-September 30, 1976, 2:41511 (GEAP-21304-3)
LWR safety research in the Federal Republic of Germany, 2:41525 (IAEA-CN-36/541)
Safety aspects and operating experience of LWR plants in Japan, 2:41526 (IAEA-CN-36/544)
Summary of LWR safety research in the USA, 2:41530 (IAEA-CN-36/584)
BWR-6 TYPE REACTORS
See GE STANDARD REACTOR

C

CADARACHE RAPSODIE REACTOR
See RAPSODIE REACTOR
CADMIUM/ABSORPTION SPECTROSCOPY
Determination of trace metals in crude oils by nonflame atomic absorption spectroscopy, 2:41014
Novel wet-digestion procedure for trace-metal analysis of coal by atomic absorption, 2:40836
CADMIUM/X-RAY EMISSION ANALYSIS
Investigation of size-dependent concentration of trace elements in aerosols emitted from the oil-fired heating plants, 2:40986 (N-76-27720)
CADMIUM STANNATES
Cadmium stannate selective optical films for solar energy applications. Final report, 1 Jul 1973-31 Aug 1976, 2:41228 (PB-261850)
CADMIUM SULFIDE SOLAR CELLS/ECONOMICS
Assessment of cadmium sulfide photovoltaic arrays for large scale electric utility applications. Final report, 2:41199 (PB-255646)
CADMIUM SULFIDE SOLAR CELLS/ELECTRICAL PROPERTIES
Dark currents in cuCu_2S-CdS single crystal heterojunctions--consequences for photocells, 2:41195
CADMIUM SULFIDE SOLAR CELLS/FABRICATION
Ternary compound thin film solar cells. Quarterly report No. 3, 1 Mar-31 May 76 ($CuInSe_2$/CdS), 2:41190 (PB-256254)
CADMIUM SULFIDE SOLAR CELLS/PERFORMANCE
Ternary compound thin film solar cells. Quarterly report No. 3, 1 Mar-31 May 76 ($CuInSe_2$/CdS), 2:41190 (PB-256254)
CADMIUM SULFIDE SOLAR CELLS/SPECTRALLY SELECTIVE SURFACES
Cadmium stannate selective optical films for solar energy applications. Final report, 1 Jul 1973-31 Aug 1976, 2:41228 (PB-261850)
CAFB PROCESS
(Chemically active fluidized bed process.)
Preliminary environmental assessment of the CAFB. Final report, Aug 1975-May 1976, 2:40979 (PB-262001)
CALCIUM/ABSORPTION SPECTROSCOPY
Novel wet-digestion procedure for trace-metal analysis of coal by atomic absorption, 2:40836
CALCIUM/ACTIVATION ANALYSIS
Mode of occurrence of trace elements in petroleum and relationship to oil-spill identification methods, 2:41027
CALCIUM/BIOLOGICAL EFFECTS
Indomethacin induces rat uterine contractions in vitro and alters reactivity to calcium and acetylcholine, 2:42068

CALCIUM 40 TARGET/ALPHA REACTIONS
Energy dependence of the optical model parameters for α-particles scattered from ^{40}Ca and ^{58}Ni (< 85.6 MeV; differential cross sections), 2:42202
CALCIUM CARBONATES/USES
Chemical composition and effectiveness of oil shale ash and cement kiln flue dust as liming fertilizers, 2:41069 (PB-254559-T/SL)
CALCIUM CHLORIDES/OSMOSIS
Review of osmotic coefficients of aqueous $CaCl_2$ at 25°C, 2:41877
CALCIUM FLUORIDES/CRYSTAL FIELD
Ab initio calculations of the crystal field splittings for Np^{3+} centers in CaF_2 (as well as for selected other complexes) by molecular orbital techniques, 2:41823
CALCIUM FLUORIDES/MOLECULAR ORBITAL METHOD
Ab initio calculations of the crystal field splittings for Np^{3+} centers in CaF_2 (as well as for selected other complexes) by molecular orbital techniques, 2:41823
CALCIUM OXIDES/STABILITY
Technology for using sulfate waste in highway construction. Final report, 2:40850 (PB-254815)
CALCIUM SULFATES/STABILITY
Technology for using sulfate waste in highway construction. Final report, 2:40850 (PB-254815)
CALIFORNIA/OIL FIELDS
Recent surface movements in the Baldwin Hills, Los Angeles County, California, 2:40937
CALIFORNIA/PETROLEUM DEPOSITS
The potential and economics of enhanced oil recovery. Final report, 2:40932 (PB-254991)
CALIFORNIUM 252/NEUTRON SOURCES
Californium-252 fission spectrum irradiation facility for neutron reaction rate measurements, 2:41154
CANADA
See also ALBERTA
QUEBEC
CANADA/ENERGY POLICY
Mandatory Canadian crude oil allocation regulations. Environmental impact statement (final), 2:41634 (PB-255319)
CANADA/GOVERNMENT POLICIES
Crude supply alternatives for the northern tier states. Volume I. Executive summary, 2:41643 (PB-255992)
Crude supply alternatives for the northern tier states. Volume II. Technical report, 2:41644 (PB-255993)
CANADA/RADIOACTIVE WASTE MANAGEMENT
Management of radioactive wastes from nuclear fuels and power plants in Canada, 2:41116 (IAEA-CN-36/178)
CANADA/URANIUM RESERVES
1974 assessment of Canada's uranium supply and demand, 2:41070 (INIS-mf-3382)
1975 assessment of Canada's uranium supply and demand, 2:41071 (INIS-mf-3388)
CANCER
See NEOPLASMS
CANDU TYPE REACTORS/FUEL CYCLE
CANDU: Canadian experience and expectations with the heavy-water reactor, 2:41367 (IAEA-CN-36/179)
CANDU TYPE REACTORS/FUEL ELEMENTS
CANDU fuel: fifteen years of power reactor experience, 2:41368 (IAEA-CN-36/184)
CANDU TYPE REACTORS/PLANNING
CANDU: Canadian experience and expectations with the heavy-water reactor, 2:41367 (IAEA-CN-36/179)
If Canada CANDU--can we, 2:41377
Nuclear power: its value is distorted for political ends, 2:41376
CANDU TYPE REACTORS/REACTOR PROTECTION SYSTEMS
Safety of heavy-water reactors, 2:41518 (IAEA-CN-36/181)
CANONICAL EQUATIONS
See DIFFERENTIAL EQUATIONS
CARBON
See also GRAPHITE
PYROLYTIC CARBON
CARBON/ACTIVATION ANALYSIS
Application of Bremsstrahlung activation analysis to the determination of carbon and nitrogen in sodium, 2:41865 (CEA-CONF-3657)
CARBON/PHYSICAL RADIATION EFFECTS
Carbon ribbon gauge for electron beam diagnostics. Final report, 2:41926 (AD-A-026905)
CARBON/VACUUM COATING
Coatings for directional eutectics. Final report (NiCrAlCy coating for NiTaC-13), 2:41814 (N-76-29370)
CARBON 12 REACTIONS/FUSION REACTIONS
Time-dependent Hartree-Fock calculation of $^{12}C + ^{12}C$ with a realistic potential (3.2 to 64 MeV/nucleon), 2:42199
CARBON 12 TARGET/CARBON 12 REACTIONS
Time-dependent Hartree-Fock calculation of $^{12}C + ^{12}C$ with a realistic potential (3.2 to 64 MeV/nucleon), 2:42199
CARBON 13/NUCLEAR MAGNETIC RESONANCE
Nuclear magnetic resonance of carbon 13 and nitrogen 15 in uranium and thorium carbonitrides, 2:41824
CARBON 13 REACTIONS/INELASTIC SCATTERING
Nuclear and Coulomb deformation parameters in ^{142}Nd (67.5 MeV; angular distribution, DWBA analysis), 2:42205
CARBON COMPOUNDS/COATINGS
Coatings for directional eutectics. Final report (NiCrAlCy coating for NiTaC-13), 2:41814 (N-76-29370)
CARBON COMPOUNDS/OXIDATION
Coatings for directional eutectics. Final report (NiCrAlCy coating for NiTaC-13), 2:41814 (N-76-29370)
CARBON DIOXIDE/ANAEROBIC DIGESTION
Investigation of converting the product of coal gasification to methane by the action of microorganisms: Phase I. Third quarterly report, May 1, 1976-August 1, 1976, 2:41169 (FE-2203-12)
CARBON DIOXIDE/AVAILABILITY
Carbon dioxide sources and oilfields in a nine-state area of the southwest United States, 2:40930 (BERC/IC-77/1)
CARBON DIOXIDE/REMOVAL
New concept for in situ coal gasification, 2:40791
Supplemental pipeline gas from coal by the Hydrane process, 2:40792
Ways of reducing heat losses in the regeneration of alkali absorbents (Ammonia synthesis gas purification), 2:41173
CARBON DIOXIDE/SUBLIMATION
Role of Taylor instability on sublimation of a horizontal slab of dry ice, 2:41554
CARBON DIOXIDE LASERS/DESIGN
Design of a high-pressure multi-kilowatt CO_2 laser, 2:41892 (AD-A-028234)
CARBON DIOXIDE LASERS/GAIN
Characteristics of CO_2 TE-amplifiers with different uv preionization at superatmospheric pressure with doping additives, 2:41917
CARBON DIOXIDE LASERS/MATHEMATICAL MODELS
Excitation and relaxation studies of molecular lasers. Annual report, 15 Feb 1975-14 Feb 1976, 2:41905 (PB-253669)
CARBON DIOXIDE LASERS/OPTICAL PUMPING
Excitation and relaxation studies of molecular lasers. Annual report, 15 Feb 1975-14 Feb 1976, 2:41905 (PB-253669)
CARBON DIOXIDE LASERS/RESEARCH PROGRAMS
Scalable nanosecond CO_2 laser technology. Progress report for period November 7, 1976-January 7, 1977, 2:41901 (COO-4055-1)
CARBON DIOXIDE LASERS/REVIEWS
Optics research, 1976:1. Semiannual technical summary report, 1 Jan-30 Jun 1976, 2:41896 (AD-A-034583)
CARBON MONOXIDE/ANAEROBIC DIGESTION
Investigation of converting the product of coal gasification to methane by the action of microorganisms: Phase I. Third quarterly report, May 1, 1976-August 1, 1976, 2:41169 (FE-2203-12)
CARBON MONOXIDE/CHEMICAL REACTIONS
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
CARBON MONOXIDE/METHANATION
Mass-spectrometric measurements of enhanced methanation activity over cobalt and nickel foils. Interim report, 2:41170 (AD-A-034675)
CARBON MONOXIDE/MONITORING
Development of fuel cell CO detection instruments for use in a mine atmosphere. Summary contract report, 1 Jan 1975-30 Jan 1976, 2:40913 (PB-254823)
CARBON MONOXIDE/SAMPLING
Regional air pollution study: quality assurance audits. Final report, 2:41967 (PB-255313)
CARBON MONOXIDE/STANDARDS
Guideline for public reporting of daily air quality: Pollutant Standards Index (PSI). Final report, 2:41992 (PB-257892)
CARBON MONOXIDE/SYNTHESIS
Mass-spectrometric measurements of enhanced methanation activity over cobalt and nickel foils. Interim report, 2:41170 (AD-A-034675)
CARBONACEOUS MATERIALS/CARBONIZATION
Formation of anisotropic mesophase from various carbonaceous materials in early stages of carbonization (350-500°C), 2:40736
CARBONACEOUS MATERIALS/CHEMICAL PROPERTIES
Estimation of the reducing properties of ferrocoke as a carbonaceous reducing agent in the smelting of ferroalloys, 2:40828
CARBONACEOUS MATERIALS/OXIDATION
Investigation of the kinetics of the oxidation of schungite and of glassy carbon, 2:41876
Kinetics of the reaction of a coal-graphite material with oxygen, 2:40833
CARBONIZATION/BY-PRODUCTS
Low-temperature lignite tar: processing and utilization, 2:40812

CARBOXYLIC ACIDS
See also AMINO ACIDS
DICARBOXYLIC ACIDS
CARBOXYLIC ACIDS/CHEMICAL COMPOSITION
Monosomic analysis of fatty acid composition in embryo lipids of Zea mays L, 2:42033
CARBOXYLIC ACIDS/CHEMICAL REACTIONS
Oxyethylation of the phenols and carboxylic acids of the low-temperature tars from the thermal treatment of coals, 2:40810
CARBOXYLIC ACIDS/PHYSICAL PROPERTIES
Oxyethylation of the phenols and carboxylic acids of the low-temperature tars from the thermal treatment of coals, 2:40810
CARCINOGENESIS
Review of the carcinogenicities of nickel, chromium, and arsenic compounds in man and animals, 2:42132
CARCINOGENS
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
CARCINOGENS/BIBLIOGRAPHIES
Environmental carcinogens (a bibliography with abstracts). Report for 1964-Nov 1976, 2:42131 (NTIS/PS-76/964)
CARDIAC PACEMAKERS/RADIOISOTOPE BATTERIES
Generic environmental statement on routine use of plutonium-powered cardiac pacemakers. Final report, 2:42138 (PB-255197)
CASKS/PERFORMANCE TESTING
Research and development of spent fuel shipping casks and the criteria for seagoing vessel carrying casks, 2:41889 (IAEA-CN-36/155)
CASTRATION/BIOLOGICAL EFFECTS
Response of gonadectomized mice to erythropoietic stimulation, 2:42029
CATALYSTS/CHEMICAL PREPARATION
Hydrocracking of residual oils and tars. V. Surface-coated cobalt molybdate catalysts for hydro-treating, 2:41063
CATALYSTS/CHEMICAL PROPERTIES
Catalyst development program for hydrodesulfurization and liquefaction of coal to produce clean boiler fuels. Quarterly report, September-November 1976, 2:40795 (FE-2321-8)
CATALYSTS/MATERIALS TESTING
Catalyst development for coal liquefaction. Annual report, 2:40796 (PB-254400)
CATALYSTS/PERFORMANCE
Theoretical interpretation of gas oil selectivity data on x-sieve catalyst, 2:40956
CELL CULTURES/CULTURE MEDIA
Lymphoid colonies (Cell cultures on methylcellulose culture system), 2:42039 (UCD-472-123)
CELL MEMBRANES/MORPHOLOGICAL CHANGES
Intrinsic material properties of the erythrocyte membrane indicated by mechanical analysis of deformation, 2:42040
CELL WALL/BIOCHEMISTRY
Structure of plant cell walls. Purification and characterization of a β-1,4-galactanase which degrades a structural component of the primary cell walls of dicots, 2:42036
CELLS (ANIMAL)
See ANIMAL CELLS
CELLS (BACTERIAL)
See BACTERIA
CELLS (PLANT)
See PLANT CELLS
CENTRAL RECEIVERS/FEASIBILITY STUDIES
Closed cycle, high-temperature central receiver concept for solar electric power, 2:41202 (PB-254399)
CENTRAL RECEIVERS/HEAT EXCHANGERS
Heat pipe central solar receiver. Semiannual progress report, March 1, 1976-August 31, 1976, 2:41201 (COO/2839-1)
CENTRAL RECEIVERS/HEAT PIPES
Heat pipe central solar receiver. Semiannual progress report, March 1, 1976-August 31, 1976, 2:41201 (COO/2839-1)
CERIUM ALLOYS/SOLID SOLUTIONS
Splat cooling of some actinide alloys, 2:41760
CERIUM ALLOYS/SPLAT COOLING
Splat cooling of some actinide alloys, 2:41760
CESIUM/FISSION PRODUCT RELEASE
Potential releases of cesium from irradiated fuel in a transportation accident. Supplement II to WASH-1238. Environmental survey of transportation of radioactive materials to and from nuclear power plants. Technical report, 2:41110 (PB-254786)
CESIUM/PHYSICAL PROPERTIES
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
CESIUM/THERMODYNAMIC PROPERTIES
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
CESIUM 137/RADIATION MONITORING
Appendix to health and safety laboratory environmental quarterly (Tabulated data on fallout radioactivity in environment), 2:41987 (HASL-318(App.))
CESIUM 137/TRANSMUTATION
Transmutation of strontium-90 and cesium-137 in a high-flux fast reactor with a thermalized central region, 2:41460
CESIUM FLUORIDES/CRYSTAL FIELD
Ab initio calculations of the crystal field splittings for Np^{3+} centers in CaF_2 (as well as for selected other complexes) by molecular orbital techniques, 2:41823
CESIUM FLUORIDES/MOLECULAR ORBITAL METHOD
Ab initio calculations of the crystal field splittings for Np^{3+} centers in CaF_2 (as well as for selected other complexes) by molecular orbital techniques, 2:41823
CHARGED PARTICLES/LET
Radiological physics and dosimetry research with a small positive ion accelerator, 2:42076 (BNWL-SA-5966)
CHARS/CHEMICAL COMPOSITION
Pyrolysis of large coal blocks: implications of heat and mass transport effects for in situ gasification (3 refs; comparison of block and powder pyrolysis), 2:40798 (CONF-770301-13)
CHARS/CHEMICAL REACTION KINETICS
Reaction kinetics of coal char gasification under conditions expected in underground coal gasification, 2:40776 (MERC/SP-76/3)
CHEMICAL EFFLUENTS/AIR POLLUTION
Preliminary look at the diurnal behavior of the PBL (Environmental transport of air pollutants), 2:41952 (ANL-75-60(Pt.4))
CHEMICAL EFFLUENTS/ENVIRONMENTAL TRANSPORT
Environmental monitoring at Argonne National Laboratory. Annual report for 1976, 2:41961 (ANL-77-13)
NSF-RANN trace contaminants abstracts, 2:42117 (ORNL/EIS-107)
PBL scaling using surface flux information (Scales of similarity theory for the planetary boundary layer), 2:41953 (ANL-75-60(Pt.4))
PBL structure: the Sangamon Experiment of 1975 (Physical mechanisms for regional air pollution in Illinois), 2:41951 (ANL-75-60(Pt.4))
Preliminary look at the diurnal behavior of the PBL (Environmental transport of air pollutants), 2:41952 (ANL-75-60(Pt.4))
Sangamon Experiment: geostrophic wind profiles (Direct measurement), 2:41954 (ANL-75-60(Pt.4))
CHEMICAL EFFLUENTS/MONITORING
Environmental monitoring at Argonne National Laboratory. Annual report for 1976, 2:41961 (ANL-77-13)
CHEMICAL EXPLOSIVES/DETONATIONS
Rapid heating-to-ignition of high explosives. I. Friction heating (PBX 9404), 2:41942
CHEMICAL EXPLOSIVES/SHAPE
Generalized shaped charge design. Final report, October 1975-October 1976, 2:41940 (UCID-17379)
CHEMICAL FEEDSTOCKS
See also PETROCHEMICALS
Coal technology program progress report for February 1977, 2:40732 (ORNL/TM-5858)
CHEMICAL INDUSTRY/ECONOMETRICS
Economic analysis of environment and energy in the petroleum refining, electric power, and chemical industries, 2:41638
CHEMICAL INDUSTRY/ENVIRONMENT
Economic analysis of environment and energy in the petroleum refining, electric power, and chemical industries, 2:41638
CHEMICAL LASERS/GAS FLOW
Laser velocimetry measurements in the cavity of HF chemical laser (cavity injector type CL-II), 2:41907 (SAND-76-9314)
CHEMICAL LASERS/POWER
Variable-aperture calorimeter for an unstable resonator. Interim report, 2:41891 (AD-A-026576)
CHEMICAL LASERS/REVIEWS
Combustion driven cw high power lasers, 2:41903 (N-76-24562)
CHEMICAL LASERS/WINDOWS
Chemical laser window measurements. Final report 7 May 1975-6 May 1976, 2:41893 (AD-A-028402)
CHEMICAL REACTORS/DESIGN
Supplemental pipeline gas from coal by the Hydrane process, 2:40792
CHEMICAL REACTORS/PERFORMANCE
Experience in operating catalytic reforming reactor with radial feed input and thin bed of catalyst, 2:40944
CHLORINE/VOLTAMETRY
Coulometric micro-determination of sulphur and chloride in mineral oils, deposits, and solvent-extraction residues, 2:41019
Microcoulometric determination of sulphur at sub-ppm levels using the standby technique, 2:41020
CHLOROPLASTS/PHOTOCHEMISTRY
Biological solar energy conversion: approaches to overcome yield, stability and product limitations. Progress report No. 3, 1 Apr 1976-30 Sep 1976, 2:41198 (PB-261910)
CHONDROSARCOMAS
See SARCOMAS

CHROMATES/SPECTROSCOPY
Laser Raman spectrometric determination of oxy-anions in nuclear waste materials, 2:41868 (ARH-SA-279)
CHROMIUM ALLOYS
See also INCONEL ALLOYS
STAINLESS STEELS
STELLITE
CHROMIUM ALLOYS/FORGING
High-toughness titanium alloy development. Final engineering report Jan 1975-May 1976, 2:41756 (AD-A-030274)
CHROMIUM ALLOYS/HEAT TREATMENTS
High-toughness titanium alloy development. Final engineering report Jan 1975-May 1976, 2:41756 (AD-A-030274)
CHROMIUM ALLOYS/THERMOELECTRIC PROPERTIES
Thermoelectric properties of solid solutions based on uranium and thorium, 2:41805
CHROMIUM ALLOYS/VACUUM COATING
Coatings for directional eutectics. Final report (NiCrAlCy coating for NiTaC-13), 2:41814 (N-76-29370)
CHROMIUM COMPOUNDS/BIOLOGICAL EFFECTS
Review of the carcinogenicities of nickel, chromium, and arsenic compounds in man and animals, 2:42132
CHROMIUM-MOLYBDENUM STEELS/CORROSION
Creep and creep--rupture properties of $2\frac{1}{4}$Cr2Mo steel for fast breeder reactor in high temperature sodium, 2:41794
CHROMIUM-MOLYBDENUM STEELS/CREEP
Creep and creep--rupture properties of $2\frac{1}{4}$Cr2Mo steel for fast breeder reactor in high temperature sodium, 2:41794
High-temperature piping design technology quarterly technical progress report, October-December 1976 (LMFBR), 2:41378 (AI-ERDA-13191)
CHROMIUM-MOLYBDENUM STEELS/DECARBURIZATION
Creep and creep--rupture properties of $2\frac{1}{4}$Cr2Mo steel for fast breeder reactor in high temperature sodium, 2:41794
CHROMIUM-MOLYBDENUM STEELS/FATIGUE
High-temperature piping design technology quarterly technical progress report, October-December 1976 (LMFBR), 2:41378 (AI-ERDA-13191)
CHROMIUM-MOLYBDENUM STEELS/RUPTURES
Creep and creep--rupture properties of $2\frac{1}{4}$Cr2Mo steel for fast breeder reactor in high temperature sodium, 2:41794
CHROMOSPHERE/ENERGY TRANSPORT
Multi-satellite attitude prediction program/Orbiting Solar Observatory-8 (MSAP/OSO-8) operating guide, 2:42164 (N-76-27304)
CISTRONS
See GENES
CLEO STELLARATOR/PLASMA CONFINEMENT
Confinement studies in Culham stellarators with ohmic heating currents, 2:42211 (AED-Conf-76-506-008)
CLINCH RIVER BREEDER REACTOR/FUEL ASSEMBLIES
Clinch River Breeder Reactor Plant. Appendix A. Flow diagram for the VARR II program, 2:41351 (CRBRP-ARD-0106(Vol.2))
Clinch River Breeder Reactor Plant. Appendix B. FORTRAN IV index listing of the VARR II program, 2:41381 (CRBRP-ARD-0106(Vol.3))
CLINCH RIVER BREEDER REACTOR/MANAGEMENT
Human factors in CRBRP design and planning for safety, 2:41406 (ORNL/TM-5681)
CLINCH RIVER BREEDER REACTOR/PERSONNEL
Human factors in CRBRP design and planning for safety, 2:41406 (ORNL/TM-5681)
CLINCH RIVER BREEDER REACTOR/REACTOR CONTROL SYSTEMS
Human factors in CRBRP design and planning for safety, 2:41406 (ORNL/TM-5681)
CLINCH RIVER BREEDER REACTOR/REACTOR COOLING SYSTEMS
Outlet plenum flow stratification studies for the Clinch River Breeder Reactor Plant, 2:41422
CLINCH RIVER BREEDER REACTOR/REACTOR KINETICS
Critical experiments and analysis twenty-first quarterly report, October-December 1976, 2:41386 (GEAP-13771-21)
CLINCH RIVER BREEDER REACTOR/SHIELDING
Direct-coupled-ray method for three-dimensional shielding analysis, 2:41467 (CONF-770401-9)
Measurements and calculations of neutron fluxes through a simulation of the CRBR upper axial shielding, 2:41380 (CONF-770401-8)
CLINCH RIVER BREEDER REACTOR/STEAM GENERATORS
Effective boiler feed control for test loops, 2:41424
COAL
See also ANTHRACITE
BITUMINOUS COAL
BROWN COAL
COAL GASIFICATION
COAL LIQUEFACTION
LIGNITE
SOLVENT-REFINED COAL
SUBBITUMINOUS COAL
COAL/AGGLOMERATION
Agglomeration in coal preparation (Oil agglomeration), 2:40739
COAL/CALORIFIC VALUE
Estimation of some properties of South African coals from proximate analyses, 2:40841
COAL/CARBONIZATION
Coal I: current advances in coal chemistry and mining techniques (Book), 2:40834
Coal processing, 2:40733
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
Coal technology program progress report for February 1977, 2:40732 (ORNL/TM-5858)
Optical properties of carbonized preoxidized vitrinites (300-800 degrees C), 2:40837
COAL/CHARGES
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
COAL/CHEMICAL ANALYSIS
Novel wet-digestion procedure for trace-metal analysis of coal by atomic absorption, 2:40836
Use of a flame photometric detector for the analysis of coal sulfur (With 3940A filter which eliminates interferences), 2:40835
COAL/CHEMICAL COMPOSITION
Coal I: current advances in coal chemistry and mining techniques (Book), 2:40834
Determination of the rate of chemosorption of oxygen by coals, 2:40819
Estimation of some properties of South African coals from proximate analyses, 2:40841
Feasibility of in-situ coal gasification in the Warrior coalfield; a progress report, 2:40747 (MERC/SP-76/3)
Laws of the distribution of normal and isoprenoid alkanes in coals of different ranks, 2:40832
COAL/CHEMICAL PROPERTIES
Blending design using many kinds of coal and the evaluation system for single coal, 2:40734
COAL/CHEMICAL REACTIONS
Coal processing, 2:40733
Reactions of coal with nitrogen/hydrogen mixtures in a discharge, 2:40844
Reactions of coal with discharge-generated (excited) nitrogen species, 2:40845
COAL/CHROMATOGRAPHY
Thermal transformations of coals and some coal-graphite materials, 2:40800
COAL/COKING
Blending design using many kinds of coal and the evaluation system for single coal, 2:40734
Energy savings by programmed heating of coke ovens, 2:40738
Solving the coking coal problem, 2:40735
COAL/COMBUSTION PROPERTIES
Further development of the burning profile, 2:40910
COAL/COMMINUTION
Ammonia injection scheme for fracturing and permeability enhancement of coal beds, 2:40780 (MERC/SP-76/3)
COAL/CONSUMPTION RATES
Monthly energy review, June 1976, 2:41601 (NTISUB/B-127-76/006)
COAL/COST
Monthly energy review, June 1976, 2:41601 (NTISUB/B-127-76/006)
COAL/DATA COMPILATION
Monthly energy review, 2:40911 (NTISUB/B-127-76/009)
COAL/DEMETALLIZATION
Rejection of trace metals from coal during beneficiation by agglomeration, 2:40904
COAL/DENSITY
Study by density measurement of changes in pore structures of coals with heat treatment. II. Micropore structure (100-1200°C; density measurements in n-hexane, methanol and helium), 2:40838
COAL/DEPOLYMERIZATION
Catalysts for the depolymerization of mature coals, 2:40842
COAL/DESULFURIZATION
Agglomeration in coal preparation (Oil agglomeration), 2:40739
Bacterial oxidation in upgrading pyritic coals, 2:40740
Chemical cleaning of coal, 2:40742
Flotation of pyrite from coal: pilot plant study, 2:40741
COAL/ELECTRIC CONDUCTIVITY
Electrometric method of finding spontaneous heating sites in coal, 2:40816
Fundamental aspects of in situ electrocarbonization and electrogasification of coal, 2:40787 (MERC/SP-76/3)

COAL/FLOTATION
Investigation of the floatability of coals of different ranks by measuring the heat effects of wetting, 2:40823
COAL/FLUIDIZED-BED COMBUSTION
Coal power and combustion. Quarterly report, April-June 1976, 2:40907 (ERDA-76-94/2)
Coal technology program progress report for January 1977, 2:40731 (ORNL/TM-5819)
COAL/HYDROGENATION
Basic studies of coal pyrolysis and hydrogasification. Quarterly progress report No. 4, 21 Feb-20 May 1976, 2:40743 (PB-254878)
Chemical reactions of the paramagnetic centers of coal pitch and the products of the hydrogenation of coals, 2:40831
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
Mathematical description of the hydrocracking of distillates from the liquid-phase hydrogenation of coal, 2:40744
Research and development of rapid hydrogenation for coal conversion to synthetic motor fuels (Riser Cracking of Coal). Third Quarter Report, October 1-December 31, 1976, 2:40794 (FE-2307-13)
COAL/IGNITION
Ignition of coalbeds for underground gasification (Longwall underground generator), 2:40781 (MERC/SP-76/3)
COAL/MARKET
The potential of coal as a commodity to be traded on United States commodity exchanges. Preliminary evaluation, 2:41641 (PB-258636)
COAL/MECHANICAL PROPERTIES
Mechanical properties of coal for simulation of underground gasification processes, 2:40815 (MERC/SP-76/3)
Thermo-viscoelastic considerations associated with underground coal gasification (Temperature dependence), 2:40765 (MERC/SP-76/3)
COAL/MICROSTRUCTURE
Study by density measurement of changes in pore structures of coals with heat treatment. II. Micropore structure (100-1200°C; density measurements in n-hexane, methanol and helium), 2:40838
COAL/OPTICAL PROPERTIES
Coal I: current advances in coal chemistry and mining techniques (Book), 2:40834
Optical roperties of carbonized vitrinites (20-950°C), 2:40840
Oxidized vitrinites: their aromaticity, optical properties, and possible detection, 2:40839
COAL/OXIDATION
Characterization of naphthalenedicarboxylic acids. I. Ultraviolet absorption spectra, 2:41869
Method of determining the suitability of a solid fuel for storage, 2:40909
COAL/PETROLOGY
Optical properties of carbonized preoxidized vitrinites (300-800 degrees C), 2:40837
Optical roperties of carbonized vitrinites (20-950°C), 2:40840
Oxidized vitrinites: their aromaticity, optical properties, and possible detection, 2:40839
COAL/PHYSICAL PROPERTIES
Blending design using many kinds of coal and the evaluation system for single coal, 2:40734
COAL/PLASTICITY
Thermo-viscoelastic considerations associated with underground coal gasification (Temperature dependence), 2:40765 (MERC/SP-76/3)
COAL/POROSITY
Study by density measurement of changes in pore structures of coals with heat treatment. II. Micropore structure (100-1200°C; density measurements in n-hexane, methanol and helium), 2:40838
COAL/PRODUCTION
Delmas breaks coal output barrier, 2:40898
COAL/PYROLYSIS
Basic studies of coal pyrolysis and hydrogasification. Quarterly progress report No. 4, 21 Feb-20 May 1976, 2:40743 (PB-254878)
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
Coal technology program progress report for January 1977, 2:40731 (ORNL/TM-5819)
Coal technology program progress report for February 1977, 2:40732 (ORNL/TM-5858)
Pyrolysis of large coal blocks: implications of heat and mass transport effects for in situ gasification (3 refs; comparison of block and powder pyrolysis), 2:40798 (CONF-770301-13)
Pyrolytic mass spectrometry of coals at low ionizing voltages, 2:40826
Studies of the emission of elemental nitrogen from coals of different rank and its release under geochemical conditions, 2:40846
Thermal transformations of coals and some coal-graphite materials, 2:40800
Two-dimensional studies of coal pyrolysis: preliminary results (Large instrumented blocks), 2:40799 (MERC/SP-76/3)
COAL/QUANTITATIVE CHEMICAL ANALYSIS
Pyrolytic mass spectrometry of coals at low ionizing voltages, 2:40826
COAL/RESEARCH PROGRAMS
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
International Energy Agency: coal research, 2:40730
COAL/SAMPLING
Blending design using many kinds of coal and the evaluation system for single coal, 2:40734
COAL/SORPTIVE PROPERTIES
Determination of the rate of chemosorption of oxygen by coals, 2:40819
Preliminary laboratory and modeling studies on the environmental impact of 'in-situ' coal gasification, 2:40753 (MERC/SP-76/3)
COAL/SPONTANEOUS COMBUSTION
Electrometric method of finding spontaneous heating sites in coal, 2:40816
COAL/STORAGE
Determination of the rate of chemosorption of oxygen by coals, 2:40819
Method of determining the suitability of a solid fuel for storage, 2:40909
COAL/STRUCTURAL CHEMICAL ANALYSIS
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
COAL/SURFACE PROPERTIES
Investigation of the floatability of coals of different ranks by measuring the heat effects of wetting, 2:40823
COAL/TEMPERATURE DISTRIBUTION
Electrometric method of finding spontaneous heating sites in coal, 2:40816
COAL/THERMAL DEGRADATION
Thermal transformations of coals and some coal-graphite materials, 2:40800
COAL/TRANSPORT
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
Preliminary engineering and economic evaluation of underspoil haulage in area strip coal mines. Part I. Summary report, 27 Jun-10 Oct 1975, 2:40874 (PB-254575)
Study of continuous face haulage systems. Final report, 2:40899 (PB-255841)
Transport of coal by shuttle trains at Dymitrow colliery, 2:40886
COAL/WASHING
Coal washing offers benefits, 2:40906
COAL/WETTABILITY
Investigation of the floatability of coals of different ranks by measuring the heat effects of wetting, 2:40823
COAL DEPOSITS
Sedimentary structures and paleocurrents in a tertiary deltaic succession, Northern Banks Basin, Arctic Canada, 2:40864
COAL DEPOSITS/BOREHOLES
Design schemes of small diameter drillings in coal deposits, 2:40890
COAL DEPOSITS/CHEMICAL COMPOSITION
Effect of mining on methane emission and concentration in return air, 2:40889
Feasibility of combined determination of the natural and residual methane content of a coal seam, the methane pressure in the seam, the sorption isotherms, and the gas emission kinetics, 2:40817
Geomathematical prediction of sulphur in coal, New Lingan Mine area, Sydney coalfield, 2:40867
COAL DEPOSITS/ELECTRIC POTENTIAL
Nature and distribution of self-potential in worked coal seams, 2:40865
COAL DEPOSITS/GEOLOGIC STRUCTURES
Geological and mining conditions of coal deposits in safety pillars in the Upper Silesian coalfield, 2:40866
COAL DEPOSITS/HYDRAULIC FRACTURING
Design criteria for hydraulic fracturing of coal beds, 2:40813 (MERC/SP-76/3)
Hydraulic fracturing thin coal seams in preparation for in situ gasification, 2:40814 (MERC/SP-76/3)
COAL DEPOSITS/PHYSICAL PROPERTIES
Feasibility of combined determination of the natural and residual methane content of a coal seam, the methane pressure in the seam, the sorption isotherms, and the gas emission kinetics, 2:40817
COAL DEPOSITS/PRESSURE MEASUREMENT
Feasibility of combined determination of the natural and residual methane content of a coal seam, the methane pressure in the seam, the sorption isotherms, and the gas emission kinetics, 2:40817

COAL DEPOSITS/ROCK BURSTS
Mine surveying and rock bursts prevention at 'bergbau '76', 2:40895
COAL DEPOSITS/SPONTANEOUS COMBUSTION
Study of the fire risk of brown coals of the Kharanorskoe deposit, 2:40821
COAL FINES/ADHESION
Adhesion of micron sized coal particles to a massive coal substrate, 2:40843
COAL FINES/CLEANING
Possibility of cleaning Polish coal fines by oil flocculation, 2:40902
COAL FINES/FLOCCULATION
Possibility of cleaning Polish coal fines by oil flocculation, 2:40902
COAL GAS/CHEMICAL COMPOSITION
Coal technology program progress report for January 1977, 2:40731 (ORNL/TM-5819)
Pyrolysis of large coal blocks: implications of heat and mass transport effects for in situ gasification (3 refs; comparison of block and powder pyrolysis), 2:40798 (CONF-770301-13)
COAL GAS/COMBUSTION PROPERTIES
Process of combustion of a mixture of natural, coking, and blast-furnace gases in a reversible combined burner with controlled spray, 2:41031
COAL GAS/PHYSICAL PROPERTIES
Pyrolysis of large coal blocks: implications of heat and mass transport effects for in situ gasification (3 refs; comparison of block and powder pyrolysis), 2:40798 (CONF-770301-13)
COAL GASIFICATION
See also COALCON PROCESS
HYDRANE PROCESS
IN-SITU GASIFICATION
LURGI PROCESS
Production of refined intermediate fuels with high temperature reactors, 2:41450 (IAEA-CN-36/376)
COAL GASIFICATION/COMPARATIVE EVALUATIONS
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
Coal technology program progress report for February 1977, 2:40732 (ORNL/TM-5858)
Factors influencing the economics of large-scale in situ coal gasification operations, 2:40754 (MERC/SP-76/3)
COAL GASIFICATION/COST
Assessment of very high-temperature reactors in process applications. Appendix III. Engineering evaluation of process heat applications for very-high temperature reactors, 2:40788 (ORNL/TM-5411)
COAL GASIFICATION/ECONOMICS
Alternative liquid fuels and the ERDA program, 2:41639
COAL GASIFICATION/FORECASTING
Some thoughts on coal gasification, 2:40793
COAL GASIFICATION/PILOT PLANTS
Basic studies of coal pyrolysis and hydrogasification. Quarterly progress report No. 4, 21 Feb-20 May 1976, 2:40743 (PB-254878)
COAL GASIFICATION PLANTS/FEASIBILITY STUDIES
Coal gasification in southeastern Ohio: water supply and demand. Completion report, 2:40789 (PB-254836)
COAL LIQUEFACTION
Production of refined intermediate fuels with high temperature reactors, 2:41450 (IAEA-CN-36/376)
COAL LIQUEFACTION/CATALYSTS
Catalyst development for coal liquefaction. Annual report, 2:40796 (PB-254400)
COAL LIQUEFACTION/COST
Assessment of very high-temperature reactors in process applications. Appendix III. Engineering evaluation of process heat applications for very-high temperature reactors, 2:40788 (ORNL/TM-5411)
COAL LIQUEFACTION/ECONOMICS
Alternative liquid fuels and the ERDA program, 2:41639
COAL LIQUEFACTION/MATHEMATICAL MODELS
Model for the extractive coal liquefaction. I. Modeling and simulation of the NenKen coal liquefaction process, 2:40797
COAL LIQUEFACTION/RESEARCH PROGRAMS
Catalyst development program for hydrodesulfurization and liquefaction of coal to produce clean boiler fuels. Quarterly report, September-November 1976, 2:40795 (FE-2321-8)
Research and development of rapid hydrogenation for coal conversion to synthetic motor fuels (Riser Cracking of Coal). Third Quarter Report, October 1-December 31, 1976, 2:40794 (FE-2307-13)
COAL LIQUIDS/COMBUSTION
Coal power and combustion. Quarterly report, April-June 1976, 2:40907 (ERDA-76-94/2)
COAL LIQUIDS/HYDROCRACKING
Mathematical description of the hydrocracking of distillates from the liquid-phase hydrogenation of coal, 2:40744
COAL MINERS/EDUCATION
Concept feasibility study for training equipment to improve coal productivity. Volume 2. Appendices. Final report, 2:40877 (PB-254864)
COAL MINERS/INJURIES
Roof-fall resupport accidents, a study. Information Circular, 1976, 2:40880 (PB-262119)
COAL MINES/ACCIDENTS
Roof-fall resupport accidents, a study. Information Circular, 1976, 2:40880 (PB-262119)
COAL MINES/AIR QUALITY
Development of fuel cell CO detection instruments for use in a mine atmosphere. Summary contract report, 1 Jan 1975-30 Jan 1976, 2:40913 (PB-254823)
COAL MINES/DEGASSING
Longwall gob degasification with surface ventilation boreholes above the lower Kittanning coalbed. Report of investigations, 2:40881 (PB-262189)
COAL MINES/FIRE HAZARDS
Electrometric method of finding spontaneous heating sites in coal, 2:40816
COAL MINES/FIRES
Experimental coal mine fire research, 2:40912 (MERC/SP-76/3)
COAL MINES/LAND RECLAMATION
Development of pre-mining and reclamation plan rationale for surface coal mines, 2:40858 (PB-258041-SET/SL)
Development of pre-mining and reclamation plan rationale for surface coal mines. Volume I. The rationale for data acquisition. Final report, 2:40859 (PB-258042)
Development of pre-mining and reclamation plan rationale for surface coal mines. Volume II. Methods of data acquisition. Final report, 2:40860 (PB-258043)
Development of pre-mining and reclamation plan rationale for surface coal mines. Volume III. Legal controls of surface mining. Final report, 2:40861 (PB-258044)
COAL MINES/LIGHTING SYSTEMS
Present state and future prospects of development of coal pit lighting, 2:40891
COAL MINES/MINING EQUIPMENT
Mechanical conveying and handling on the 'Bergbau 76', 2:40896
COAL MINES/PRODUCTIVITY
Survey of equipment manufacturing research and development needs. Final report, 2:40875 (PB-254768)
COAL MINES/SAFETY
Effect of mining on methane emission and concentration in return air, 2:40889
COAL MINES/SUBSURFACE STRUCTURES
Influence of vibration parameters on the process of advancing a shield-type support, 2:40883
COAL MINES/SUPPORTS
Problem of safe undermining of seams in the light of practical experience gained in Nowy Wirek colliery, 2:40888
Road supports at the International Mining Exposition 1976, 2:40894
COAL MINES/TRANSPORTATION SYSTEMS
Automation of main wheel transport exemplified on Staszic colliery, 2:40887
Probabilities of states of a bunker in transient conditions, 2:40884
Transport of coal by shuttle trains at Dymitrow colliery, 2:40886
COAL MINES/VENTILATION
Longwall gob degasification with surface ventilation boreholes above the lower Kittanning coalbed. Report of investigations, 2:40881 (PB-262189)
COAL MINES/WASTE DISPOSAL
Coal mine waste (a bibliography with abstracts). Report for 1964-Nov 1976 (99 abstracts), 2:40870 (NTIS/PS-77/0040)
COAL MINING
See also SURFACE MINING
UNDERGROUND MINING
COAL MINING/BIBLIOGRAPHIES
Bibliography on analysis and design of coal mine structures using finite element techniques, 2:40878 (PB-255944)
COAL MINING/ENVIRONMENTAL EFFECTS
Demonstration of coal mine haul road sediment control techniques. Final report, 2:40879 (PB-258304)
Environmental impact of open pit mining in the conclusions of 'bergbau '76', 2:40863
COAL MINING/ENVIRONMENTAL IMPACTS
Application of EREP imagery to fracture-related mine safety hazards in coal mining and mining-environmental problems in Indiana. Final report Apr 73-Apr 75, 2:40869 (E-76-10419)
COAL MINING/LAWS
Development of pre-mining and reclamation plan rationale for surface coal mines. Volume III. Legal controls of surface mining. Final report, 2:40861 (PB-258044)
COAL MINING/MATHEMATICAL MODELS
Probabilities of states of a bunker in transient conditions, 2:40884
COAL MINING/MINING EQUIPMENT
Coal cutting with a disk, 2:40885

Comparative analysis of cutter and drill splitting mechanisms of mining machines, 2:40882
Innovations and trends in face supports at the international mining exposition 1976, 2:40893
Road supports at the International Mining Exposition 1976, 2:40894
Roadheading technique at the 9th World Mining Congress, 2:40897
Survey of equipment manufacturing research and development needs. Final report, 2:40875 (PB-254768)
Winning and stowing at 'Bergbau '76' exposition, 2:40892
COAL MINING/SAFETY
Mine surveying and rock bursts prevention at 'bergbau '76', 2:40895
COAL MINING/SURFACE MINING
Strip mining in the corn belt: the destruction of high capability agricultural land for strip-minable coal in Illinois, 2:41642
COAL PREPARATION
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
Rejection of trace metals from coal during beneficiation by agglomeration, 2:40904
COAL PREPARATION/COMPUTER CALCULATIONS
Coal technology program progress report for February 1977, 2:40732 (ORNL/TM-5858)
COAL PREPARATION/EQUIPMENT
Coal preparation technique at 'Bergbau '76', 2:40905
COAL PREPARATION PLANTS/PRODUCTIVITY
Technical progress in development of mechanical coal preparation in Poland in the five year period 1971-1975, 2:40901
COAL RANK
Blending design using many kinds of coal and the evaluation system for single coal, 2:40734
COAL RESERVES
Coal resources for the fertilizer plant at Korba, Madhya Pradesh, 2:40868
COAL TAR/PROCESSING
Extraction of useful chemical derivatives from coal (Book), 2:40811
Low-temperature lignite tar: processing and utilization, 2:40812
COAL TAR ACIDS/CHEMICAL REACTIONS
Oxyethylation of the phenols and carboxylic acids of the low-temperature tars from the thermal treatment of coals, 2:40810
COAL TAR ACIDS/PHYSICAL PROPERTIES
Oxyethylation of the phenols and carboxylic acids of the low-temperature tars from the thermal treatment of coals, 2:40810
COAL TAR OILS/CHEMICAL COMPOSITION
Pyrolysis of large coal blocks: implications of heat and mass transport effects for in situ gasification (3 refs; comparison of block and powder pyrolysis), 2:40798 (CONF-770301-13)
COAL TAR OILS/CRACKING
Pyrolysis of large coal blocks: implications of heat and mass transport effects for in situ gasification (3 refs; comparison of block and powder pyrolysis), 2:40798 (CONF-770301-13)
COAL TAR OILS/PHYSICAL PROPERTIES
Pyrolysis of large coal blocks: implications of heat and mass transport effects for in situ gasification (3 refs; comparison of block and powder pyrolysis), 2:40798 (CONF-770301-13)
COALCON PROCESS/FLOWSHEETS
Coal power and combustion. Quarterly report, April-June 1976, 2:40907 (ERDA-76-94/2)
COAL-DERIVED LIQUIDS
See COAL LIQUIDS
COAL-FIRED MHD GENERATORS/RESEARCH PROGRAMS
Development program for MHD direct coal-fired power generation test facility. Quarterly technical progress report, July-September 1976, 2:41659 (FE-1760-26)
COAL-FIRED MHD GENERATORS/TEST FACILITIES
Development program for MHD direct coal-fired power generation test facility. Quarterly technical progress report, July-September 1976, 2:41659 (FE-1760-26)
COASTAL WATERS/BOUNDARY LAYERS
Physical oceanography and sediment transport on the Washington continental shelf. Report of progress, October 1975-September 1976 (Pacific Ocean), 2:42146 (RLO-2225-T25-18)
COASTAL WATERS/HYDRODYNAMICS
Physical oceanography and sediment transport on the Washington continental shelf. Report of progress, October 1975-September 1976 (Pacific Ocean), 2:42146 (RLO-2225-T25-18)
COATED FUEL PARTICLES/AMOEBA EFFECT
Uranium loss from BISO-coated weak-acid-resin HTGR fuel, 2:41361 (ORNL/TM-5552)
COATED FUEL PARTICLES/FUEL DENSIFICATION
Uranium loss from BISO-coated weak-acid-resin HTGR fuel, 2:41361 (ORNL/TM-5552)
COATED FUEL PARTICLES/PHYSICAL RADIATION EFFECTS
HTGR fuels and core development program. Quarterly progress report for the period ending February 28, 1977, 2:41355 (GA-A-14298)
COATINGS/ELECTROPLATING
Electrolytic coating of microparticles for laser fusion targets, 2:41148 (LA-6584)
COATINGS/INSPECTION
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
COATINGS/NONDESTRUCTIVE TESTING
Coal technology program progress report for February 1977, 2:40732 (ORNL/TM-5858)
COATINGS/PERFORMANCE TESTING
Testing of coatings for the nuclear industry, 2:41466 (CONF-770301-12)
COBALT/ABSORPTION SPECTROSCOPY
Determination of trace metals in crude oils by nonflame atomic absorption spectroscopy, 2:41014
Novel wet-digestion procedure for trace-metal analysis of coal by atomic absorption, 2:40836
COBALT/CATALYTIC EFFECTS
Mass-spectrometric measurements of enhanced methanation activity over cobalt and nickel foils. Interim report, 2:41170 (AD-A-034675)
COBALT/DEUTERON REACTIONS
Proton sputtering. Final report (500 eV to 8 keV), 2:42318 (ORO-3557-15)
COBALT/HEALTH HAZARDS
Hazards of cobalt, 2:42133
COBALT/PROTON REACTIONS
Proton sputtering. Final report (500 eV to 8 keV), 2:42318 (ORO-3557-15)
COBALT/SPUTTERING
Proton sputtering. Final report (500 eV to 8 keV), 2:42318 (ORO-3557-15)
COBALT 60/COSMOCHEMISTRY
Cosmogenic radionuclides in stone meteorites, 2:42173 (N-76-25115)
COBALT 60/DIFFUSION
Impurity diffusion of cobalt in plutonium, 2:41798
COBALT ALLOYS
See also COBALT BASE ALLOYS
COBALT ALLOYS/MAGNETIZATION
Itinerant magnetism in $NpFe_2Si_2$ and $NpCo_2Si_2$, 2:41799
COBALT BASE ALLOYS
See also STELLITE
COBALT BASE ALLOYS/DEPOSITION
Sputter-deposition of metastable Ta-Pu, Ag-Pu and Co-Pu alloys, 2:41759
COBALT BASE ALLOYS/SPUTTERING
Sputter-deposition of metastable Ta-Pu, Ag-Pu and Co-Pu alloys, 2:41759
COBALT CARBIDES/WEAR
Durability of tungsten-cobalt carbide alloys, 2:41785 (N-76-28369)
COKE/CHEMICAL REACTIONS
Investigation of some physicochemical processes in pitch-coke compositions, 2:40829
COKE/MECHANICAL PROPERTIES
Thermal breakdown of coke in the cooling process, 2:40827
COKE/MOLECULAR STRUCTURE
Molecular structure of pyrolysis coke, 2:40966
COKE/PHYSICAL PROPERTIES
Solving the coking coal problem, 2:40735
COKE/PRODUCTION
Solving the coking coal problem, 2:40735
COKE/RESEARCH PROGRAMS
Solving the coking coal problem, 2:40735
COKE/SURFACE PROPERTIES
Investigation of some physicochemical processes in pitch-coke compositions, 2:40829
COKE/TENSILE PROPERTIES
Influence of various factors on the change in the tensile strength of coke, 2:40824
COKE/THERMAL STRESSES
Thermal breakdown of coke in the cooling process, 2:40827
COKE/WETTABILITY
Investigation of some physicochemical processes in pitch-coke compositions, 2:40829
COKE OVENS/MATHEMATICAL MODELS
Energy savings by programmed heating of coke ovens, 2:40738
COKE-OVEN GAS
See COAL GAS
COLD PLASMA/ELECTROMAGNETIC RADIATION
Excitation of electromagnetic waves in the range of plasma resonance in inhomogeneous plasma by nonlinear langmuir oscillations, 2:42260

COLLAGEN/MOLECULAR STRUCTURE
Neutron scattering by collagen, 2:42023 (BNL-50453)
COLLISIONLESS PLASMA/ELECTRON PLASMA WAVES
Generation of plasma waves by Gaussian laser beam and stimulated Raman scattering, 2:42268
COLLISIONLESS PLASMA/LASER RADIATION
Analytical investigation of the optical mixing of two laser beams of identical frequencies in a spatially homogeneous collisionless plasma, 2:42222
COLUMBIUM
See NIOBIUM
COMBINED-CYCLE POWER PLANTS/ECONOMICS
Utilization of low BTU gas from in-situ coal gasification for on-site power generation, 2:40773 (MERC/SP-76/3)
COMBINED-CYCLE POWER PLANTS/EFFICIENCY
Utilization of low BTU gas from in-situ coal gasification for on-site power generation, 2:40773 (MERC/SP-76/3)
COMBINED-CYCLE POWER PLANTS/OPERATION
Mastering the steam-and-gas 200 MW power unit and prospects of application of high-capacity steam-and-gas plants in power generation, 2:41257
COMBUSTION KINETICS/COMPUTER CODES
Hybrid computer program for rapidly solving flowing or static chemical kinetic problems involving many chemical species, 2:41963 (N-76-29382)
COMBUSTION PRODUCTS/CHEMICAL COMPOSITION
In Situ Hydrocarbon Recovery Simulation Laboratory research at Morgantown Energy Research Center, 2:40779 (MERC/SP-76/3)
COMBUSTION PRODUCTS/GAS CHROMATOGRAPHY
In Situ Hydrocarbon Recovery Simulation Laboratory research at Morgantown Energy Research Center, 2:40779 (MERC/SP-76/3)
COMBUSTORS/TURBULENT FLOW
An investigation of ducted, two-stream, variable-density, turbulent jet mixing with recirculation. Final report, 23 May 1975-30 Jun 1976, 2:41922 (AD-A-034537)
COMECON
(Council for Mutual Economic Assistance.)
COMECON/NUCLEAR POWER
Co-operation of the CMEA member countries in the developing power reactors of various types, including some aspects of their nuclear fuel cycles, 2:41301 (IAEA-CN-36/6)
COMMODITIES
The potential of coal as a commodity to be traded on United States commodity exchanges. Preliminary evaluation, 2:41641 (PB-258636)
COMMUNITIES/UNDERGROUND
Alternative to suburbia, 2:41591 (NSF-RA-760006)
COMPATIBILITY (IMMUNOLOGICAL)
See IMMUNITY
COMPONENT COOLING SYSTEMS
See AUXILIARY WATER SYSTEMS
COMPOSITE MATERIALS/CORROSION
Sea water corrosion. Volume 1. 1964-1975 (a bibliography with abstracts). Report for 1964-1975, 2:41815 (NTIS/PS-77/0052)
COMPOSITE MATERIALS/MECHANICAL PROPERTIES
Materials research at Stanford University. Annual report, 1 Jul 1975-30 Jun 1976, 2:41862 (N-76-30026)
COMPOSITE MATERIALS/PHYSICAL PROPERTIES
Materials research at Stanford University. Annual report, 1 Jul 1975-30 Jun 1976, 2:41862 (N-76-30026)
COMPOUND PARABOLIC CONCENTRATORS/DESIGN
Development of compound parabolic concentrators for solar thermal applications, 2:41231
COMPOUND PARABOLIC CONCENTRATORS/PERFORMANCE
Development of compound parabolic concentrators for solar thermal applications, 2:41231
COMPOUNDS (ORGANIC)
See ORGANIC COMPOUNDS
COMPUTER CODES/D CODES
DPAK and HPAK: a versatile display and histogramming package (In FORTRAN for IBM 360/370), 2:42330 (SLAC-196)
COMPUTER CODES/F CODES
FLAIR: a scaling and folding code for the generation of photon transport results in air. Final report, 2:42208 (AD-A-034754)
COMPUTER CODES/H CODES
DPAK and HPAK: a versatile display and histogramming package (In FORTRAN for IBM 360/370), 2:42330 (SLAC-196)
COMPUTER CODES/I CODES
ISA: Ineractive Stress Analysis. A program for plane stress, plane strain and axisymmetric analysis of structural continua. User's manual (HTGR), 2:41472 (ORNL/Sub/4164-2)
COMPUTER CODES/N CODES
Assessment of non-linear analysis finite element program (NONSAP) for inelastic analysis, 2:41465 (BNL-NUREG-50615)
Network capability estimation. Vela network evaluation and automatic processing research. Technical report (NETWORTH), 2:41948 (AD-A-034897)
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COMPUTER CODES/P CODES
PREPR2: a program to aid in the preparation of input data for the farout hydraulic transport code, 2:41495 (ORNL/CSD/TM-19)
COMPUTER CODES/R CODES
CDC6600 subroutine for normal random variables (RVNORM (RMU, SIG)), 2:42329 (SAND-77-0612)
Operation and maintenance of the Rare-Earth Information Center's Information Retrieval System (RICIRS) version 2 (In PL/I for IBM 360 or 370 OSMVT), 2:42337 (IS-4104)
COMPUTER CODES/S CODES
'STEALTH' a Lagrange explicit finite-difference code for solids structural, and thermohydraulic analysis. Technical report (Nuclear reactor design), 2:41456 (PB-255405)
Preaccident modeling of an LMFBR plant for SSC-L, 2:41509 (BNL-NUREG-50602(Pt.1))
COMPUTER CODES/U CODES
UCOST: a planning, scheduling, and costing system, 2:41703
COMPUTER CODES/V CODES
Clinch River Breeder Reactor Plant. Appendix A. Flow diagram for the VARR II program, 2:41351 (CRBRP-ARD-0106(Vol.2))
Clinch River Breeder Reactor Plant. Appendix B. FORTRAN IV index listing of the VARR II program, 2:41381 (CRBRP-ARD-0106(Vol.3))
COMPUTER GRAPHICS/COMPUTER CODES
DPAK and HPAK: a versatile display and histogramming package, 2:42330 (SLAC-196)
COMPUTERS/MEMORY DEVICES
"Almost-exact" solution to the N-processor, M-memory bandwidth problem. Technical report No. 117, 2:42333 (SU-SEL-76-025)
COMPUTERS/RESEARCH PROGRAMS
Studies in the organization of computer systems. 1976 progress summary. Technical note No. 100 (Digital Systems Lab., Department of Electrical Engineering and Computer Science, Stanford Univ.), 2:42332 (SU-326-P.39-16)
CONDENSED AROMATICS
See also ANTHRACENE
NAPHTHALENE
PYRENE
CONDENSED AROMATICS/CHROMATOGRAPHY
Coal technology program progress report for January 1977, 2:40731 (ORNL/TM-5819)
CONDENSED AROMATICS/MASS SPECTRA
Coal technology program progress report for January 1977, 2:40731 (ORNL/TM-5819)
CONDENSED AROMATICS/MASS SPECTROSCOPY
Mass-spectrometric analysis of group composition of saturated petroleum hydrocarbons in crude oil, 2:40968
CONDENSER COOLING SYSTEMS
See also AUXILIARY WATER SYSTEMS
CONDENSER COOLING SYSTEMS/PERFORMANCE
Simulation of spray canal cooling for power plants--performance and environmental effects, 2:41484
CONNECTICUT YANKEE REACTOR/ENVIRONMENTAL IMPACTS
Evaluation of nuclear power plant environmental impact prediction, based on monitoring programs. Summary and recommendations, 2:41492 (BNWL-2153)
CONSERVATION (RESOURCE)
See RESOURCE CONSERVATION
CONTAINMENT BUILDINGS/COATINGS
Testing of coatings for the nuclear industry, 2:41466 (CONF-770301-12)
CONTAINMENT SYSTEMS/DESIGN
Trends in the development of reactor containments, 2:41469 (IAEA-CN-36/306)
CONTAINMENT SYSTEMS/PRESSURE SUPPRESSION
Reactor containment analysis for BWR suppression systems. Progress report, October-December 1976, 2:41538 (UCRL-50045-76-4)
CONTAMINATION (INTERNAL)
See RADIONUCLIDE KINETICS
CONTROL ELEMENTS/STANDARDS
Control rod assembly for liquid metal fast breeder reactors, 2:41437 (RDT-E-6-33T)
CONTROL ROD DRIVES/ACTUATORS
Magnetic jack control rod drives (PWR), 2:41491

CONTROL ROD DRIVES/DISPLACEMENT GAGES
Fault tolerant, multiplexed control rod position detection and indication system for nuclear power plants (PWR), 2:41349
CONTROL RODS
See CONTROL ELEMENTS
CONTROL THEORY (REACTOR)
See REACTOR KINETICS
CONVEYORS/DESIGN
Preliminary engineering and economic evaluation of underspoil haulage in area strip coal mines. Part I. Summary report, 27 Jun-10 Oct 1975, 2:40874 (PB-254575)
COOLANT CLEANUP SYSTEMS
Economical removal of sodium water reaction products (SWRP) from an LMFBR intermediate heat transport system (IHTS), 2:41417
COOLERS
See HEAT EXCHANGERS
COOLING PONDS/ENVIRONMENTAL EFFECTS
Eddy-flux measurements at the Dresden cooling pond (Fluxes of heat and momentum above Dresden reactors cooling pond), 2:42014 (ANL-75-60(Pt.4))
Preliminary study of the relationship between surface and bulk water temperatures at the Dresden cooling pond, 2:42000 (ANL-75-60(Pt.4))
COOLING PONDS/MATHEMATICAL MODELS
Simulation of spray canal cooling for power plants--performance and environmental effects, 2:41484
COOLING PONDS/TEMPERATURE MEASUREMENT
Examination of some bulk formulae used for assessing the performance of industrial cooling ponds, 2:42001 (ANL-75-60(Pt.4))
Preliminary tests of a model of cooling-pond thermal performance, 2:42002 (ANL-75-60(Pt.4))
COOLING SYSTEM (REACTOR)
See REACTOR COOLING SYSTEMS
COOLING TOWERS
See also NATURAL DRAFT COOLING TOWERS
COOLING TOWERS/DESIGN
Minimum weight design of cooling towers, 2:41253 (N-76-30612)
COOLING TOWERS/ENVIRONMENTAL EFFECTS
Environmental impact assessment of cooling towers, 2:41499
COOLING TOWERS/PERFORMANCE TESTING
Performance of an evaporative cooler, 2:41256
COPPER/ABSORPTION SPECTROSCOPY
Evaluation of a carbon-rod atomizer for routine determination of trace metals by atomic-absorption spectroscopy. Applications to analysis of lubricating oil and crude oil, 2:41016
Novel wet-digestion procedure for trace-metal analysis of coal by atomic absorption, 2:40836
COPPER/ENVIRONMENTAL TRANSPORT
Trace element geochemistry of the South Atlantic Bight. Progress report, June 1, 1976-May 31, 1977, 2:42147 (SRO-890-2)
COPPER/MECHANICAL PROPERTIES
Semi-annual report on materials research in support of superconducting machinery. Final report (Composite materials), 2:41784 (PB-261996)
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)
COPPER/MINERAL CYCLING
Exchange of manganese, iron, copper, and zinc between dissolved and particulate forms in the Newport River estuary, North Carolina, 2:42003 (RLO-2227-T12-71)
COPPER/NEUTRON REACTIONS
Calculations of the neutron emission spectra from materials bombarded with 14-mev neutrons, 2:42290
COPPER/PHYSICAL RADIATION EFFECTS
Fusion power program. Quarterly progress report, October-December 1976, 2:42314 (ANL/FPP-76-6)
COPPER/TENSILE PROPERTIES
Tensile behavior of unnotched and notched tungsten-copper laminar composites, 2:41782 (N-76-26287)
COPPER/THERMAL CONDUCTIVITY
Semi-annual report on materials research in support of superconducting machinery. Final report (Composite materials), 2:41784 (PB-261996)
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)
COPPER ALLOYS
See also COPPER BASE ALLOYS
COPPER ALLOYS/FRACTURE PROPERTIES
Nonlinear compliance curves caused by crack closure in fracture tests of tungsten alloy, 2:41786
COPPER BASE ALLOYS/CORROSION
Corrosion in condensers and coolers of nuclear power due to cooling water, 2:41813 (EBO-P-673)
COPPER BASE ALLOYS/MECHANICAL PROPERTIES
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)
COPPER BASE ALLOYS/THERMAL CONDUCTIVITY
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)
CORDOVA QUAD CITIES-1 REACTOR
See QUAD CITIES-1 REACTOR
CORDOVA QUAD CITIES-2 REACTOR
See QUAD CITIES-2 REACTOR
CORE FLOODING SYSTEMS/HEAT TRANSFER
Prediction of reflood heat transfer with standard loop programs (BWR;PWR), 2:41553
CORIUM/CHEMICAL COMPOSITION
Properties of light water reactor core melts, 2:41555
CORIUM/THERMAL CONDUCTIVITY
Properties of light water reactor core melts, 2:41555
CORIUM/VISCOSITY
Properties of light water reactor core melts, 2:41555
CORONA (SOLAR)
See SOLAR CORONA
CORROSION INHIBITORS/TESTING
Evaluating refinery process side corrosion inhibitors, 2:40952
COSMIC GAMMA BURSTS
Powerful bursts of cosmic gamma radiation, 2:42161 (N-76-29149)
COSMIC NEUTRONS/FLUX DENSITY
Low fluxes of x rays. Final report, 2:41936 (N-76-30279)
COSMIC PARTICLES
See COSMIC RADIATION
COSMIC PHOTONS/ENERGY SPECTRA
Reanalysis of the Apollo cosmic gamma-ray spectrum in the 0.3 to 10 MeV energy region, 2:42149 (N-76-28148)
COSMIC PROTONS/FLUX DENSITY
Low fluxes of x rays. Final report, 2:41936 (N-76-30279)
COSMIC RADIATION
See also COSMIC GAMMA BURSTS
PRIMARY COSMIC RADIATION
Multi-satellite attitude prediction program/Orbiting Solar Observatory-8 (MSAP/OSO-8) operating guide, 2:42164 (N-76-27304)
COSMIC RADIATION/TRAJECTORIES
Summary of cutoff rigidities calculated with the International Geomagnetic Reference Field for various epochs. Environmental research papers, 2:42148 (AD-A-028978)
COSMIC RAY DETECTION/GAS SCINTILLATION DETECTORS
Gas scintillation proportional counter for x-ray astronomy, 2:41928 (N-76-27550)
COSMIC X-RAY SOURCES
Powerful bursts of cosmic gamma radiation, 2:42161 (N-76-29149)
COSMIC X-RAY SOURCES/ENERGY SPECTRA
X-ray emission from the supernova remnant G287.8-0.5, 2:42157 (N-76-27135)
COSMIC X-RAY SOURCES/PHOTOMETRY
All-Sky Monitor observations of the decay of A0620-00 (Nova Monocerotis 1975), 2:42158 (N-76-28120)
COSMIC X-RAY SOURCES/RADIATION DETECTION
Fabrication of a focusing soft x-ray collector payload. Final report, 22 Nov 1972-30 Jun 1976, 2:41929 (N-76-30527)
COSMIC X-RAY SOURCES/X-RAY SPECTRA
The 35-d x-ray profile of Her X-1, 2:42160 (N-76-31109)
COUNTERS (RADIATION)
See RADIATION DETECTORS
CRBR REACTOR
See CLINCH RIVER BREEDER REACTOR
C-REACTIVE PROTEIN
See IMMUNITY
CRIME DETECTION/BIBLIOGRAPHIES
Time series forecasting and prediction (a bibliography with abstracts). Report for 1964-Jan 1977, 2:41666 (NTIS/PS-77/0042)
CROPS/SOLAR DRYING
Solar energy applications in agriculture: potential, research needs, and adoption strategies, summary and recommendations, 2:41217 (PB-255928)
CRUDE OIL
See PETROLEUM
CULTURES (CELLS)
See CELL CULTURES
CURIUM OXIDES/PHASE STUDIES
New phases in curium-oxygen system, 2:41834
CURIUM OXIDES/PHYSICAL RADIATION EFFECTS
Structural changes in actinide dioxides under self- and reactor irradiation, 2:41857
CUTTING TOOLS/COMPARATIVE EVALUATIONS
Comparative analysis of cutter and drill splitting mechanisms of mining machines, 2:40882
CYANIDES/AEROSOL MONITORING
Gas chromatographic analysis of air pollutants, 2:41985
CYCLES (THERMODYNAMIC)
See THERMODYNAMIC CYCLES

CYCLONE SEPARATORS/COMPARATIVE EVALUATIONS
Utilization of low BTU gas from in-situ coal gasification for on-site power generation, 2:40773 (MERC/SP-76/3)
CYCLOTRON INSTABILITY
Plasma thermonuclear cyclotron-magnetoacoustic instability, 2:42248
CZECHOSLOVAKIA/NUCLEAR POWER
Research programs in nuclear technology (Czechoslovakia), 2:41439 (INIS-mf-3391)
CZECHOSLOVAKIA/NUCLEAR POWER PLANTS
Main ways of nuclear power development, 2:41310 (INIS-mf-3391)

D

D REGION/CHEMICAL COMPOSITION
Rocket-borne time-of-flight mass spectrometry, 2:42184 (N-76-28723)
D REGION/ELECTROMAGNETIC PULSES
Experimental study of the nonlinear propagation of an electromagnetic pulse through the ionosphere. Final report Jun 1974-Jan 1975, 2:42188 (AD-A-030059)
D REGION/ELECTRON TEMPERATURE
Experimental study of the nonlinear propagation of an electromagnetic pulse through the ionosphere. Final report Jun 1974-Jan 1975, 2:42188 (AD-A-030059)
DATA ACQUISITION SYSTEMS
Computer-based transportable data-acquisition and control system, 2:41938 (UCRL-78339(Rev.1))
DATA STORAGE DEVICES
See MEMORY DEVICES
DAYGLOW
See AIRGLOW
DELFT HOGER ONDERWIJS REACTOR
See HOR REACTOR
DENITRIFICATION/ISOTOPE EFFECTS
Nitrogen isotope discrimination in denitrification of nitrate in soils, 2:41995
DEOXYPENTOSE NUCLEIC ACID
See DNA
DEOXYRIBONUCLEIC ACID
See DNA
DESALINATION REACTORS/ECONOMICS
Near term feasibility of nuclear reactor for sea-water desalting: coupling of standard condensing nuclear power stations to low grade heat multieffect distillation plants, 2:41447 (IAEA-CN-36/52)
DESOXYRIBONUCLEIC ACID
See DNA
DESULFURIZATION/COST
Pilot plant proves Resid process, 2:40958
DETECTORS (RADIATION)
See RADIATION DETECTORS
DETONATION WAVES
See SHOCK WAVES
DEVELOPING COUNTRIES/NUCLEAR POWER PLANTS
Arguments for the installation of small LWR nuclear power plants in developing countries, 2:41315 (IAEA-CN-36/89)
DEVELOPING COUNTRIES/POWER DEMAND
Energy in developing countries: prospects and problems, 2:41628 (IAEA-CN-36/581)
DEWARS/DESIGN
Dewar technology study. Final report, 2:41883 (N-76-27444)
DIAPHRAGMS (THERMONUCLEAR DEVICE)
See LIMITERS
DIATOMS/DISTRIBUTION
Concentration of diatom frustules in Lake Michigan sediment cores (^{210}Pb, ^{137}Cs), 2:42005
DICARBOXYLIC ACIDS/CHEMICAL PREPARATION
Characterization of naphthalenedicarboxylic acids. I. Ultraviolet absorption spectra, 2:41869
Pilot plant for producing a mixture of crude dicarboxylic acids from shale, 2:41067 (PB-254581-T/SL)
DICARBOXYLIC ACIDS/ULTRAVIOLET SPECTRA
Characterization of naphthalenedicarboxylic acids. I. Ultraviolet absorption spectra, 2:41869
Extraction of useful chemical derivatives from coal (Book), 2:40811
DIESEL ENGINES/CYLINDERS
Effect of the stroke/bore ratio on the M diesel engine, 2:41744
Effect of the stroke/bore ratio in a vehicle diesel engine with special regard to the combustion process in a hyperboloid combustion chamber, 2:41745
DIESEL ENGINES/EXHAUST GASES
Diesel emissions measurement and control, 2:41748
Toxicology of diesel emissions, 2:41749
Turbocooling and no$sub x$-emission reduction of diesel engines, 2:41751
DIESEL ENGINES/GAS FLOW
Investigation of throughput capacity of a four-stroke diesel engine during the closing of valves, 2:41719
Theoretical and experimental determination of instantaneous air flow in a combined diesel in unsteady conditions, 2:41718
DIESEL ENGINES/NOISE
Techniques for quieting the diesel, 2:41722
DIESEL ENGINES/OPERATION
Influence of diesel fuel cetane number on operating indices of engine, 2:41723
DIESEL ENGINES/POLLUTION CONTROL EQUIPMENT
New methods for reducing visible emissions of diesel engines, 2:41752
DIESEL ENGINES/SUPERCHARGERS
Turbocooling and no$sub x$-emission reduction of diesel engines, 2:41751
DIESEL ENGINES/TEMPERATURE DISTRIBUTION
Cyclic temperature fluctuations in marine diesel combustion chamber walls, 2:41721
DIESEL ENGINES/THERMODYNAMIC MODEL
Thermodynamic model of the process of ignition in a diesel engine, 2:41677
Thermophysical analysis of gas-phase processes developing in space and time in diesel units, 2:41720
DIESEL FUELS/ANTIKNOCK RATINGS
Influence of diesel fuel cetane number on operating indices of engine, 2:41723
DIESEL FUELS/CHARGES
Selling prices and taxes on motor gasoline, diesel fuel, and heating oil in selected countries, as of October 1974. International economics report 1974, 2:40975 (PB-254943)
DIESEL FUELS/QUALITY CONTROL
Influence of diesel fuel cetane number on operating indices of engine, 2:41723
DIESEL FUELS/TAXES
Selling prices and taxes on motor gasoline, diesel fuel, and heating oil in selected countries, as of October 1974. International economics report 1974, 2:40975 (PB-254943)
DIFFERENTIAL EQUATIONS
See also BOLTZMANN EQUATION
DIFFERENTIAL EQUATIONS/NUMERICAL SOLUTION
Future developments in stiff integration techniques: stability of methods that do not use an exact Jacobian, 2:42326 (COO-2383-0035)
DIOLS
See GLYCOLS
DIPLOCOCCUS PNEUMONIAE
See PNEUMOCOCCUS
DISPERSION NUCLEAR FUELS
(A dispersion of nuclear fuel particles in a solid.)
DISPERSION NUCLEAR FUELS/PHYSICAL RADIATION EFFECTS
Irradiation behaviour of UAlsub(x)-Al dispersion fuels for thermal high flux reactors, 2:41822
DISSOLVERS/PERFORMANCE TESTING
Nuclear fuel dissolution and rinsing studies using a continuous rotary dissolver, 2:41099 (ORNL/TM-5566)
DISTILLATION/CALCULATION METHODS
Non-ideal liquid activity coefficients, 2:40959
DISTILLATION/PHASE STUDIES
Non-ideal liquid activity coefficients, 2:40959
DISTRICT HEATING/BOILERS
Generator boilers, 2:41669
DISTRICT HEATING/ECONOMICS
Experimental study of utilization of nuclear power heating plants for big towns and industrial agglomerations in Russia, 2:41451 (IAEA-CN-36/465)
Reactor waste heat utilization and district heating reactors. Nuclear district heating in Sweden - Regional reject heat utilization schemes and small heat-only reactors, 2:41448 (IAEA-CN-36/275)
DISTRICT HEATING/HEAT DISTRIBUTION SYSTEMS
Waste heat utilisation by 'co-operative' group schemes, 2:41689
DISTRICT HEATING/PLANNING
Use of nuclear reactors for central heat supply and district heating, 2:41449 (IAEA-CN-36/338)
DISTRICT HEATING/STEAM GENERATORS
Thermal and temperature regimes of the experimental membrane waterwall of the PK-41 steam generator, 2:41270
DNA
(Deoxyribonucleic acid.)
DNA/BINDING ENERGY
Binding and entry of DNA in pneumococcal transformation, 2:42034
Single-strand breakage on binding of DNA to cells in the genetic transformation of Diplococcus pneumoniae, 2:42048

DNA/CROSS-LINKING
Photosensitizing effects of 8-methoxypsoralen on the skin of hairless mice. I. Formation of interstrand cross-links in epidermal DNA (UV radiation), 2:42083
DNA/STRAND BREAKS
Single-strand breakage on binding of DNA to cells in the genetic transformation of Diplococcus pneumoniae, 2:42048
DOCUMENT RETRIEVAL
See INFORMATION RETRIEVAL
DOGS
See also BEAGLES
DOGS/BIOLOGICAL RADIATION EFFECTS
Hematopoietic effects (Effects of internal ^{90}Sr and ^{226}Ra radiation, whole-body γ irradiation, and i.v.-administered fly ash silica particles), 2:42081 (UCD-472-123)
Immune competence of ^{226}Ra-injected dogs and age-matched controls as measured by the micro-lymphocyte stimulation test, 2:42087 (UCD-472-123)
DOGS/ESTROUS CYCLE
Morphologic and hormonal aspects of the estrous cycle in the dog: a review, 2:42063 (UCD-472-123)
DOGS/INTERNAL IRRADIATION
Immune competence of ^{226}Ra-injected dogs and age-matched controls as measured by the micro-lymphocyte stimulation test, 2:42087 (UCD-472-123)
DOGS/PHYSIOLOGY
Annual report, fiscal year 1976, 2:42118 (UCD-472-123)
DOGS/RADIONUCLIDE KINETICS
Present status of and future plans for ITRI's human and dog chest counting facilities, 2:42106 (BNWL-2088)
DOGS/REPRODUCTION
Morphologic and hormonal aspects of the estrous cycle in the dog: a review, 2:42063 (UCD-472-123)
DOSE DISTRIBUTIONS
See RADIATION DOSE DISTRIBUTIONS
DOUBLET-2 DEVICE/RESEARCH PROGRAMS
Doublet fusion programme - one step from electricity production, 2:42284
DOUBLET-3 DEVICE/DESIGN
Review of the conceptual design of a Doublet fusion experimental power reactor, 2:42282
DOWTHERM
See BIPHENYL
DRIFT CHAMBERS/OPERATION
Study of a particle detector with very high spatial precision (drift chambers), and analysis of the physical phenomena governing the operation of this detector, 2:41931 (CRN-HE-76-15)
DRIFT CHAMBERS/SPATIAL RESOLUTION
Study of a particle detector with very high spatial precision (drift chambers), and analysis of the physical phenomena governing the operation of this detector, 2:41931 (CRN-HE-76-15)
DRILLING EQUIPMENT/COMPARATIVE EVALUATIONS
Comparative analysis of cutter and drill splitting mechanisms of mining machines, 2:40882
DRILLING FLUIDS/PHYSICAL PROPERTIES
Design schemes of small diameter drillings in coal deposits, 2:40890
Possibilities of biopolymer utilization for drilling fluids, 2:40934
DRILLING MUD
See DRILLING FLUIDS
DRILLING PLATFORMS
See OFFSHORE PLATFORMS
DRINKING WATER/RADIOACTIVITY
Appendix to health and safety laboratory environmental quarterly (Tabulated data on fallout radioactivity in environment), 2:41987 (HASL-318(App.))
DRINKING WATER/WATER POLLUTION CONTROL
Treatment effectiveness for the removal of selected contaminants from drinking water. Final report, 2:42012 (PB-258271)
DRINKING WATER/WATER QUALITY
Treatment effectiveness for the removal of selected contaminants from drinking water. Final report, 2:42012 (PB-258271)
DROSOPHILA/HYBRIDIZATION
Evolution of 5S ribosomal RNA genes in the chromosomes of the virilis group of Drosophila (^{125}I tracer techniques), 2:42049
DUAL-PURPOSE POWER PLANTS/FEASIBILITY STUDIES
Mobile nuclear power plants: initial feasibility study. Research report (Transportable plants for industrial energy), 2:41427 (PB-258232)
DUSTS/REMOVAL
Supplemental pipeline gas from coal by the Hydrane process, 2:40792
DYE LASERS/INFRARED RADIATION
Dye laser probing of primary C_2 radicals formed by ir intense field photolysis of ethylene, 2:41916
DYE LASERS/RESEARCH PROGRAMS
Design and development of soft x-ray laser. Semi-annual technical report, Mar-Dec 1976, 2:41895 (AD-A-034326)
DYSPROSIUM PERCHLORATES/OSMOSIS
Isopiestic determination of the activity coefficients of some aqueous rare earth electrolyte solutions at 25°C. II. The rare earth perchlorates, 2:41874
DYSPROSIUM PERCHLORATES/THERMODYNAMIC PROPERTIES
Heats of dilution of some aqueous rare earth electrolyte solutions at 25°C. I. Rare earth perchlorates, 2:41873

E

E LAYER
See E REGION
E REGION/ELECTRON DENSITY
Ionospheric R-region electron density and neutral atmosphere variations, 2:42181 (N-76-27753)
Study of the conditions necessary for the onset of mid-latitude spread F, 2:42185 (N-76-29782)
EARTH ATMOSPHERE
See also AIR
IONOSPHERE
MAGNETOSPHERE
SURFACE AIR
EARTH ATMOSPHERE/NATURAL RADIOACTIVITY
Characteristics of natural radioactivity appearing in its diurnal variation, 2:41988 (N-76-24799)
EARTH ATMOSPHERE/TIDE
Ionospheric R-region electron density and neutral atmosphere variations, 2:42181 (N-76-27753)
EARTH CRUST/GEOCHEMISTRY
Geophysical and geochemical models of the Earth's shields and rift zones, 2:42140 (UCRL-52238)
EARTH CRUST/GEOPHYSICS
Geophysical and geochemical models of the Earth's shields and rift zones, 2:42140 (UCRL-52238)
EARTH CRUST/TEMPERATURE MEASUREMENT
Effect of ground cover on Earth temperature, 2:41596 (NSF-RA-760006)
EARTH CRUST/TOPOGRAPHY
Geophysical and geochemical models of the Earth's shields and rift zones, 2:42140 (UCRL-52238)
EARTH MANTLE/CHEMICAL COMPOSITION
Geophysical and geochemical models of the Earth's shields and rift zones, 2:42140 (UCRL-52238)
EARTH PLANET/RIFT ZONES
Geophysical and geochemical models of the Earth's shields and rift zones, 2:42140 (UCRL-52238)
EARTH PLANET/SHIELDS
Geophysical and geochemical models of the Earth's shields and rift zones, 2:42140 (UCRL-52238)
EARTHQUAKES/FORECASTING
Alaska Peninsula telemetered seismic network. Annual report, 2:42141 (RLO-2229-TC-3)
EARTHQUAKES/NUCLEAR EXPLOSION DETECTION
Applications of higher mode surface waves. Technical report, 2:41947 (AD-A-034883)
EARTHQUAKES/PROBABILITY
Probabilistic and statistical models for seismic risk analysis (Nuclear power plants), 2:41537 (PB-259188)
E-BEAM TYPE REACTORS/DATA ACQUISITION
Electron beam fusion data acquisition program DATAIN (EBD), 2:42319 (SAND-77-0204)
EBR-2 REACTOR/COOLANT CLEANUP SYSTEMS
Sodium purification by cold trapping at the Experimental Breeder Reactor II, 2:41426
ECCS
(Emergency core cooling system.)
See also CORE FLOODING SYSTEMS
Two-dimensional analysis of conduction-controlled rewetting with precursory cooling, 2:41547
ECCS/RESEARCH PROGRAMS
BWR blowdown/emergency core cooling third quarterly progress report, July 1-September 30, 1976, 2:41511 (GEAP-21304-3)
ECCS/TWO-PHASE FLOW
Literature search on slip and entrainment in a reactor cooling channel (PWR), 2:41531 (IKE-2-33)
ECOLOGY/GOVERNMENT POLICIES
Observations on ecology and national security. Final technical note, 2:41587 (AD-A-026597)
ECONOMIC DEVELOPMENT/ECONOMETRICS
Long-run model for energy policy analysis, 2:41635

ECR HEATING
Plasma heating in the TM-3 Tokamak at the electron cyclotron resonance in magnetic fields up to 25kGs, 2:42214 (EUR-CEA-FC-855-TR)
EFFLUENTS (CHEMICAL)
See CHEMICAL EFFLUENTS
EGGS/TEMPERATURE EFFECTS
Eggs and hatchlings of captive Dipsosaurus dorsalis, 2:42069
EHF RADIATION
See MICROWAVE RADIATION
ELECTRIC BATTERIES
(Devices for production and/or storage of electrical energy from chemical reactions; excludes FUEL CELLS and RADIOISOTOPE BATTERIES.)
See also METAL-GAS BATTERIES
METAL-NONMETAL BATTERIES
ELECTRIC BATTERIES/ANODES
Effect of additives on lithium cycling in propylene carbonate (SO_2, nitromethane, H_2O), 2:41579
Effect of additives on lithium cycling in methyl acetate (Nitromethane, SO_2, H_2O), 2:41580
ELECTRIC BATTERIES/ELECTRODES
Life capability of the silver electrode in alkaline electrochemical cells (Ag-H_2), 2:41576 (N-76-28648)
ELECTRIC BATTERIES/LEAKS
Means for detecting and neutralizing leaks in electrochemical cells (Patent), 2:41570
ELECTRIC BATTERIES/SPACERS
Battery wedge for submarines or other installations, 2:41574 (AD-D-003275)
ELECTRIC CABLES
See also OIL-FILLED CABLES
SUPERCONDUCTING CABLES
ELECTRIC CABLES/ELECTRICAL INSULATORS
Contribution to the study of initiation and propagation mechanisms of treeing in polyethylene for high voltage cables, 2:41293
High voltage polyethylene insulated cables from 63 to 225 kV and their fittings, 2:41291
Materials for high voltage cables with polyethylene or chemically cross-linked polyethylene insulation, 2:41292
ELECTRIC CABLES/MANUFACTURING
New ways for upgrading thermoplastic PE and cross-linked PE-insulated power cables, 2:41296
ELECTRIC CABLES/PERFORMANCE TESTING
Temperature and voltage tests on MgO insulated coaxial cables (LMFBR), 2:41389 (HEDL-TME-76-66)
ELECTRIC POWER/ECONOMICS
The marginal cost and pricing of electricity: an applied approach, 2:41274 (PB-255967)
ELECTRIC POWER/FORECASTING
Energy in developing countries: prospects and problems, 2:41628 (IAEA-CN-36/581)
ELECTRIC POWER/RELIABILITY
Report on equipment availability for the ten-year period, 1966-1975, 2:41648 (EEI-76-85)
ELECTRIC RAILWAYS
See also ELECTRIC-POWERED VEHICLES
RAPID TRANSIT SYSTEMS
TRAINS
ELECTRIC RAILWAYS/PHYSICAL PROTECTION DEVICES
Power supply system, particularly for the supply of auxiliary devices of a passenger cars with energy from the electric contact line (Patent), 2:41730
ELECTRIC UTILITIES
See PUBLIC UTILITIES
ELECTRICAL INSULATORS/DECOMPOSITION
Contribution to the study of initiation and propagation mechanisms of treeing in polyethylene for high voltage cables, 2:41293
ELECTRICAL INSULATORS/FABRICATION
High voltage polyethylene insulated cables from 63 to 225 kV and their fittings, 2:41291
Materials for high voltage cables with polyethylene or chemically cross-linked polyethylene insulation, 2:41292
ELECTRIC-POWERED VEHICLES
See also ELECTRIC RAILWAYS
ELECTRIC-POWERED VEHICLES/LITHIUM-SULFUR BATTERIES
High-performance batteries for off-peak energy storage and electric-vehicle propulsion. Progress report for the period July-September 1976 (Li-Al/Kcl-LiCl/Fes or FeS_2; tests of Li/TiS_2, Na/FeS_2, and $CaMg_2$/FeS cells), 2:41567 (ANL-76-98)
Metallic sulfide additives for positive electrode material within a secondary electrochemical cell (Patent; Fe sulfide electrode with sulfide additives of Co, Ni, Cu, Ce, Mn), 2:41577
ELECTRIC-POWERED VEHICLES/NICKEL-ZINC BATTERIES
Development and fabrication of large vented nickel-zinc cells. Final report (300 Ah), 2:41568 (N-76-28642)
ELECTRIC-POWERED VEHICLES/PERFORMANCE TESTING
DUO-bus, supplied either from overhead wire or from battery alternatively, 2:41733
ELECTRIC-POWERED VEHICLES/SODIUM-SULFUR BATTERIES
Anodic evolution of sulphur from sodium polysulphide melts. I. Voltammetric measurements on planar carbon electrodes, 2:41573
Metallic sulfide additives for positive electrode material within a secondary electrochemical cell (Patent; Fe sulfide electrode with sulfide additives of Co, Ni, Cu, Ce, Mn), 2:41577
ELECTRIC-POWERED VEHICLES/SYSTEMS ANALYSIS
Battery-electric road transport as part of an aggregate transport system, 2:41732
ELECTROCHEMICAL CELLS
See also ELECTRIC BATTERIES
FUEL CELLS
ELECTROCHEMICAL CELLS/LEAKS
Means for detecting and neutralizing leaks in electrochemical cells (Patent), 2:41570
ELECTROCHEMISTRY/RESEARCH PROGRAMS
Materials research at Stanford University. Annual report, 1 Jul 1975-30 Jun 1976, 2:41862 (N-76-30026)
ELECTROMAGNETIC LENSES/SUPERCONDUCTING MAGNETS
Superconducting lenses for high-voltage microscopy. Final report, 2:41884 (N-76-30534)
ELECTROMAGNETIC PULSES/ABSORPTION
Experimental validation of transient plasma effects used in high altitude electromagnetic pulse calculations. Final report, 2:42187 (AD-A-028516)
ELECTROMAGNETIC PULSES/ENERGY ABSORPTION
Experimental study of the nonlinear propagation of an electromagnetic pulse through the ionosphere. Final report Jun 1974-Jan 1975, 2:42188 (AD-A-030059)
ELECTROMAGNETIC PULSES/WAVE PROPAGATION
Experimental study of the nonlinear propagation of an electromagnetic pulse through the ionosphere. Final report Jun 1974-Jan 1975, 2:42188 (AD-A-030059)
ELECTROMAGNETIC SURVEYS/USES
Application of electromagnetic frequency sounding to groundwater problems, 2:42144
ELECTRON BEAM TYPE REACTORS
See E-BEAM TYPE REACTORS
ELECTRON BEAMS/BEAM MONITORING
Faraday cup with multiple internal filters and a primary current monitor for characterizing high dose pulsed electron beams. Final report, 2:41924 (AD-A-034613)
ELECTRON BEAMS/BEAM MONITORS
Carbon ribbon gauge for electron beam diagnostics. Final report, 2:41926 (AD-A-026905)
ELECTRON CYCLOTRON-RESONANCE H
See ECR HEATING
ELECTRON MICROSCOPES/RADIOACTIVITY
Biological effects of low levels of radiation exposure (Radiation hazards to man from radioactive consumer products), 2:42077 (UR-3490-1072)
ELECTRON PLASMA WAVES/MIXING
Non-linear mixing of dispersive waves, 2:42267
ELECTRON PLASMA WAVES/PARAMETRIC INSTABILITIES
'Enlightement' of a wave barrier under conditions of parametric instability of a pre-barric plasma, 2:42261
Plasma nonstationary turbulence while parametric resonance, 2:42257
ELECTRON PLASMA WAVES/TURBULENCE
Plasma nonstationary turbulence while parametric resonance, 2:42257
ELECTRON SOURCES/DATA ACQUISITION
Electron beam fusion data acquisition program DATAIN (EBD), 2:42319 (SAND-77-0204)
ELECTRON-ATOM COLLISIONS/DATA COMPILATION
Atomic data for controlled fusion research, 2:42231 (ORNL-5206(Vol.1))
ELECTRONIC EQUIPMENT
See also POWER SUPPLIES
ELECTRONIC EQUIPMENT/PHYSICAL RADIATION EFFECTS
EMP preferred test procedures (selected electronic parts). Revision, 2:41934 (AD-A-034791)
Internal interaction analysis: topological concepts and needed model improvements. Final report, 2:41932 (AD-A-027047)

ELECTRONIC EQUIPMENT/TESTING
EMP preferred test procedures (selected electronic parts). Revision, 2:41934 (AD-A-034791)
ELECTRON-ION COLLISIONS/DATA COMPILATION
Atomic data for controlled fusion research, 2:42231 (ORNL-5206(Vol.1))
ELECTRON-ION COLLISIONS/INELASTIC SCATTERING
Electron Boltzmann equation in a plasma generated by fission fragments, 2:42195 (N-76-29018)
ELECTRON-MOLECULE COLLISIONS/DATA COMPILATION
Atomic data for controlled fusion research, 2:42231 (ORNL-5206(Vol.1))
ELECTRON-POSITRON INTERACTIONS/ANNIHILATION
Threshold effects in annihilation processes, 2:42196 (N-76-27996)
ELECTROSTATIC PRECIPITATORS/COMPARATIVE EVALUATIONS
Utilization of low BTU gas from in-situ coal gasification for on-site power generation, 2:40773 (MERC/SP-76/3)
ELECTROSTATIC PRECIPITATORS/PERFORMANCE TESTING
Comparative U.S./USSR tests of a hot-side electrostatic precipitator. Final report, Jan 1975-Sep 1976, 2:41279 (PB-261918)
ELEMENTS
See also METALS
TRANSURANIUM ELEMENTS
ELEMENTS/TOXICITY
NSF-RANN trace contaminants abstracts, 2:42117 (ORNL/EIS-107)
EMERGENCY CORE COOLING SYSTEM
See ECCS
EMP
See ELECTROMAGNETIC PULSES
ENERGY
See also SOLAR ENERGY
ENERGY/INFORMATION SYSTEMS
Directory of Federal Energy Data Sources. Computer products and recurring publications, 2:41581 (PB-254163)
Information on international research and development activities in the field of energy, 2:41582 (PB-254315)
ENERGY ACCOUNTING
Energy embodied in goods, 2:41654 (ORAU/IEA(M)-77-6)
ENERGY CONSERVATION
Comparative life cycle costs (Earth-covered buildings), 2:41610 (NSF-RA-760006)
Comparison of energy consumption in earth-covered vs. non-earth-covered buildings, 2:41612 (NSF-RA-760006)
Evaluation of energy conservation within health facilities. Final report, 2:41678 (PB-256006)
Strategies for legislative change (To encourage earth-covered construction), 2:41633 (NSF-RA-760006)
Study of earth-covered buildings by an electric utility company, 2:41613 (NSF-RA-760006)
Terraset Elementary School, Reston, Virginia (Underground, solar-heated), 2:41616 (NSF-RA-760006)
University of Minnesota book store, 2:41614 (NSF-RA-760006)
Use of earth covered buildings through history, 2:41588 (NSF-RA-760006)
ENERGY CONSERVATION/COST BENEFIT ANALYSIS
Cost/benefit trade-offs for reducing the energy consumption of commercial air transportation (RECAT). Final report, 2:41605 (N-76-28203)
Cost/benefit trade-offs for reducing the energy consumption of commercial air transportation (RECAT). Summary report, 2:41606 (N-76-28204)
Study of cost/benefit tradeoffs for reducing the energy consumption of the commercial air transportation system (Advanced turboprop introduction), 2:41607 (N-76-31079)
ENERGY CONSERVATION/ECONOMICS
New energy economics and the role of energy conservation in buildings, 2:41611 (NSF-RA-760006)
ENERGY CONSERVATION/ENERGY POLICY
First quarterly report to U.S. house and senate committees on appropriations, 2:41626 (PB-256182)
ENERGY CONSERVATION/INTERNATIONAL COOPERATION
Observations on ecology and national security. Final technical note, 2:41587 (AD-A-026597)
ENERGY CONSERVATION/MEETINGS
Alternatives in energy conservation: the use of earth covered buildings (Conference; about 525 references), 2:41609 (NSF-RA-760006)
ENERGY CONSERVATION/PLANNING
"North Carolina Energy Policy Council" Annual report. Volume I, 2:41636
"North Carolina Energy Policy Council" Annual report. Volume II, 2:41637
ENERGY CONSERVATION/PUBLIC RELATIONS
A qualitative study of consumer attitudes toward energy conservation, 2:41583 (PB-254564)
Private individual's willingness to make energy-saving efforts and their perception of the likelihood of others doing the same. Highlight report, Volume XIX, 2:41655 (PB-255946)
Public attitudes and behavior regarding energy conservation: detailed tabulations by U.S. population and population segments. Waves 5 and 6, 2:41617 (PB-254304)
Public attitudes and behavior regarding energy conservation: detailed tabulations by U.S. population and population segments. Waves 20 and 21, 2:41618 (PB-254305)
ENERGY CONSERVATION/SOCIOLOGY
Conservation of energy in the home. Highlight report, Volume XVII. Monthly report, 2:41623 (PB-254628)
Consumption and conservation of natural gas. Highlight report, Volume XVIII. Monthly report, 2:41034 (PB-254629)
Group discussions regarding consumer energy conservation, 2:41624 (PB-254639)
Public attitudes and behavior regarding energy conservation: detailed tabulations by U.S. population segments; Waves 26 and 27. Monthly tabulated report, 2:41619 (PB-254588)
Public attitudes and behavior regarding energy conservation: detailed tabulations by U.S. population segments; Waves 22 and 23, 2:41620 (PB-254589)
Public attitudes and behavior regarding energy conservation: detailed tabulations by U.S. population segments; Waves 7 and 8. Monthly tabulated report, 2:41621 (PB-254590)
Public attitudes and behavior regarding energy conservation: detailed tabulations by U.S. population segments; Waves 3 and 4. Monthly tabulated report, 2:41622 (PB-254591)
Public attitudes and behavior regarding energy conservation: Detailed tabulations by U.S. population and population segments, Waves 1 and 2, 2:41625 (PB-255003)
ENERGY CONSERVATION/TRANSPORTATION SYSTEMS
Effect of aircraft technology improvements on intercity energy use. Final report, 2:41608 (N-76-31090)
ENERGY CONSUMPTION
Energy embodied in goods, 2:41654 (ORAU/IEA(M)-77-6)
ENERGY CONSUMPTION/BIBLIOGRAPHIES
Time series forecasting and prediction (a bibliography with abstracts). Report for 1964-Jan 1977, 2:41666 (NTIS/PS-77/0042)
ENERGY CONSUMPTION/REGULATIONS
Report to Congress by the Federal Aviation Administration on the energy efficiency of agency regulations. Final report, 2:41632 (AD-A-034611)
ENERGY DEMAND/ECONOMETRICS
Long-run model for energy policy analysis, 2:41635
Methodological survey of energy modeling, 2:41630
ENERGY DEMAND/ENERGY MODELS
Modeling the economic and environmental consequences of alternative energy policies (SEAS: Strategic Environmental Assessment System), 2:41599
ENERGY DEMAND/FORECASTING
Development of methods for forecasting the national industrial demand for energy. Final report, 2:41629 (PB-257914)
Guidelines for forecasting energy demand, 2:41627 (IA-1327)
ENERGY DEMAND/MATHEMATICAL MODELS
Long-run model for energy policy analysis, 2:41635
ENERGY MODELS
Development of methods for forecasting the national industrial demand for energy. Final report, 2:41629 (PB-257914)
Economic analysis of environment and energy in the petroleum refining, electric power, and chemical industries, 2:41638
Modeling the economic and environmental consequences of alternative energy policies (SEAS: Strategic Environmental Assessment System), 2:41599
ENERGY MODELS/ENERGY POLICY
Long-run model for energy policy analysis, 2:41635
ENERGY POLICY
Critical post-1985 energy policy issues, 2:41584 (PB-255949)
First quarterly report to U.S. house and senate committees on appropriations, 2:41626 (PB-256182)
ENERGY POLICY/ECONOMETRICS
Long-run model for energy policy analysis, 2:41635
ENERGY POLICY/ENERGY MODELS
Long-run model for energy policy analysis, 2:41635
ENERGY SHORTAGES/ECONOMICS
Consequences of the energy crisis, 2:41631
ENERGY SOURCE DEVELOPMENT/ECONOMIC IMPACT
Modeling the economic and environmental consequences of alternative energy policies (SEAS: Strategic Environmental Assessment System), 2:41599
ENERGY SOURCE DEVELOPMENT/ENVIRONMENTAL IMPACTS
Modeling the economic and environmental consequences of alternative energy policies (SEAS: Strategic Environmental Assessment System), 2:41599

ENERGY SOURCE DEVELOPMENT/SIMULATION
Methodological survey of energy modeling, 2:41630
ENERGY SOURCES
See also WASTE HEAT
WIND POWER
ENERGY SOURCES/ECONOMETRICS
Methodological survey of energy modeling, 2:41630
ENERGY SOURCES/PATENTS
Technology assessment and forecast. Sixth report (Review of patent activity), 2:41603 (PB-254188)
ENERGY SOURCES/PLANNING
"North Carolina Energy Policy Council" Annual report. Volume I, 2:41636
"North Carolina Energy Policy Council" Annual report. Volume II, 2:41637
ENERGY SUPPLIES/ECONOMETRICS
Long-run model for energy policy analysis, 2:41635
ENERGY SUPPLIES/ENERGY MODELS
Modeling the economic and environmental consequences of alternative energy policies (SEAS: Strategic Environmental Assessment System), 2:41599
ENERGY SUPPLIES/MATHEMATICAL MODELS
Long-run model for energy policy analysis, 2:41635
ENERGY SUPPLIES/PLANNING
"North Carolina Energy Policy Council" Annual report. Volume I, 2:41636
"North Carolina Energy Policy Council" Annual report. Volume II, 2:41637
ENERGY TRANSPORT/RESEARCH PROGRAMS
Materials research at Stanford University. Annual report, 1 Jul 1975-30 Jun 1976, 2:41862 (N-76-30026)
ENGINES
See also DIESEL ENGINES
HEAT ENGINES
INTERNAL COMBUSTION ENGINES
STIRLING ENGINES
Study of cost/benefit tradeoffs for reducing the energy consumption of the commercial air transportation system (Advanced turboprop introduction), 2:41607 (N-76-31079)
ENGLAND
See UNITED KINGDOM
ENHANCED RECOVERY/ECONOMICS
The potential and economics of enhanced oil recovery. Final report, 2:40932 (PB-254991)
ENVIRONMENT/AIR POLLUTION
Health and Safety Laboratory environmental quarterly, December 1, 1976-March 1, 1977, 2:42085 (HASL-318)
ENVIRONMENT/GOVERNMENT POLICIES
Environmental quality profile, 1976. Alaska, Oregon, Idaho, Washington. Final report, 2:41990 (PB-255101)
ENVIRONMENT/RADIOACTIVITY
Health and Safety Laboratory environmental quarterly, December 1, 1976-March 1, 1977, 2:42085 (HASL-318)
ENVIRONMENT/RESEARCH PROGRAMS
A review of the U.S. Environmental Protection Agency environmental research outlook, fiscal year 1976 through 1980, 2:41598 (PB-258191)
ENVIRONMENTAL IMPACTS/COMPUTER CALCULATIONS
Computer simulation of environmental impact, 2:42017
ENVIRONMENTAL IMPACTS/FORECASTING
Evaluation of nuclear power plant environmental impact prediction, based on monitoring programs. Summary and recommendations, 2:41492 (BNWL-2153)
ENVIRONMENTAL PROTECTION AGENCY/LEGAL ASPECTS
Index of EPA legal authority. Statutes and legislative history, Executive orders, regulations, 2:41597 (PB-255142)
ENVIRONMENTAL PROTECTION AGENCY/RESEARCH PROGRAMS
A review of the U.S. Environmental Protection Agency environmental research outlook, fiscal year 1976 through 1980, 2:41598 (PB-258191)
ENZYMES
See also AMINOTRANSFERASES
PHOSPHATASES
ENZYMES/METABOLISM
Structure of plant cell walls. Purification and characterization of a β-1,4-galactanase which degrades a structural component of the primary cell walls of dicots, 2:42036
Studies of temperature sensitive mutants of bacteriophage Qβ, defective in both replication and translation, 2:42045
ENZYMES/PURIFICATION
Structure of plant cell walls. Purification and characterization of a β-1,4-galactanase which degrades a structural component of the primary cell walls of dicots, 2:42036
EPA
See ENVIRONMENTAL PROTECTION AGENCY
EPIPHYSIS (BONES)
See BONE TISSUES
EPIPHYSIS (PINEAL GLAND)
See PINEAL GLAND
EPOXIDES/MECHANICAL PROPERTIES
Advanced composites: mechanical properties and hardware programs for selected resin matrix materials (Boron and graphite fiber reinforcement), 2:41860 (N-76-24364)
Semi-annual report on materials research in support of superconducting machinery. Final report (Composite materials), 2:41784 (PB-261996)
EPOXIDES/TENSILE PROPERTIES
Nonlinear analysis of laminated fibrous composites (Boron/epoxy, graphite/epoxy, borsic-aluminum), 2:41861 (N-76-27359)
EPOXIDES/THERMAL CONDUCTIVITY
Semi-annual report on materials research in support of superconducting machinery. Final report (Composite materials), 2:41784 (PB-261996)
EPOXY COMPOUNDS
See EPOXIDES
EPSTEIN-BARR VIRUS
See ONCOGENIC VIRUSES
EQUATIONS (DIFFERENTIAL)
See DIFFERENTIAL EQUATIONS
EQUILIBRIUM PLASMA/FINITE DIFFERENCE METHOD
Study of helical plasma equilibria, 2:42241
EQUILIBRIUM PLASMA/FINITE ELEMENT METHOD
Finite element approach to the computation of the MHD spectrum of straight noncircular plasma equilibria, 2:42239
EQUILIBRIUM PLASMA/MAGNETOHYDRODYNAMICS
Finite element approach to the computation of the MHD spectrum of straight noncircular plasma equilibria, 2:42239
EQUIPMENT
See also DRILLING EQUIPMENT
EQUIPMENT/PERFORMANCE TESTING
Analysis of operation of topping tower in high-capacity unit for crude oil distillation, 2:40945
ERBIUM PERCHLORATES/OSMOSIS
Isopiestic determination of the activity coefficients of some aqueous rare earth electrolyte solutions at 25°C. II. The rare earth perchlorates, 2:41874
ERBIUM PERCHLORATES/THERMODYNAMIC PROPERTIES
Heats of dilution of some aqueous rare earth electrolyte solutions at 25°C. I. Rare earth perchlorates, 2:41873
ERIE-1 REACTOR
PSAR Volume 1; introduction and general description of plant, 2:41432 (DOCKET-STN-50580-1)
ERIE-2 REACTOR
PSAR Volume 1; introduction and general description of plant, 2:41432 (DOCKET-STN-50580-1)
ERYTHROBLASTS
See BONE MARROW CELLS
ERYTHROCYTES/HEMOLYSIS
Slow phase hemolysis in hypotonic electrolyte solutions, 2:42028
ERYTHROCYTES/MORPHOLOGICAL CHANGES
Intrinsic material properties of the erythrocyte membrane indicated by mechanical analysis of deformation, 2:42040
ERYTHROPOIESIS/BIOLOGICAL RADIATION EFFECTS
Study of haemopoietic microenvironment in vitro, 2:42070
ERYTHROPOIESIS/STIMULATION
Influence of melatonin on erythropoiesis, 2:42030
Melatonin action during hypobaric hypoxia, 2:42031
Response of gonadectomized mice to erythropoietic stimulation, 2:42029
ESTROGENS/BIOCHEMICAL REACTION KINETICS
Morphologic and hormonal aspects of the estrous cycle in the dog: a review, 2:42063 (UCD-472-123)
ESTROGENS/BIOLOGICAL EFFECTS
Indomethacin induces rat uterine contractions in vitro and alters reactivity to calcium and acetylcholine, 2:42068
ESTUARIES/MINERAL CYCLING
Exchange of manganese, iron, copper, and zinc between dissolved and particulate forms in the Newport River estuary, North Carolina, 2:42003 (RLO-2227-T12-71)
ETHANE/OXIDATION
Research on electrochemical energy conversion systems. Final technical report, 1 Jul 1975-30 Jun 1976 (Trifluoromethanesulfonic acid electrolyte), 2:41663 (AD-A-034454)
1,2-ETHANEDIOL
See GLYCOLS
ETHYLENE/PHOTOLYSIS
Dye laser probing of primary C_2 radicals formed by ir intense field photolysis of ethylene, 2:41916
ETHYLENE/PRODUCTION
Operation of primary fractionation tower in unit for pyrolysis of liquid hydrocarbons, 2:40943
ETHYLENE GLYCOL
See GLYCOLS

ETHYLENE POLYMERS
See POLYETHYLENES
EUROPE
See also BELGIUM
CZECHOSLOVAKIA
GERMAN FEDERAL REPUBLIC
HUNGARY
ITALY
NETHERLANDS
POLAND
PORTUGAL
SPAIN
UNITED KINGDOM
USSR
EUROPE/FUEL REPROCESSING PLANTS
Reprocessing of fission material: a look at the European situation, 2:41102
EUROPE/PIPELINES
International gas transmission, 2:41042
EUROPEAN COMMUNITIES/NUCLEAR POWER
European Community care for nuclear power, 2:41304 (IAEA-CN-36/365)
EXCAVATION/ENVIRONMENTAL IMPACTS
Build without destroying the Earth, 2:41592 (NSF-RA-760006)
EXHAUST GASES/AEROSOL MONITORING
Gas chromatographic analysis of air pollutants, 2:41985
EXPERIMENTAL BREEDER REACTOR-2
See EBR-2 REACTOR
EXPERIMENTAL REACTORS
(For engineering testing of reactor components such as : FUEL ELEMENTS, COOLING SYSTEMS, etc.)
See also EBR-2 REACTOR
EXPERIMENTAL REACTORS/MONITORING
Comparison of two adaptive identification methods for monitoring and diagnosis of an experimental nuclear reactor, 2:42335
EXPERIMENTAL REACTORS/REACTOR CONTROL SYSTEMS
Comparison of two adaptive identification methods for monitoring and diagnosis of an experimental nuclear reactor, 2:42335
EXPLORATION
Mineral exploration trends and developments in 1976, 2:41075
EXPLOSIVES
See also CHEMICAL EXPLOSIVES
EXPLOSIVES/PRESSURE GRADIENTS
Measuring small internal pressures along a tube during steady flow, 2:41941 (UCRL-77305(Rev.1))
EXPLOSIVES/STRAINS
Measuring small internal pressures along a tube during steady flow, 2:41941 (UCRL-77305(Rev.1))
EXTRACTION COLUMNS/PERFORMANCE
Pulse columns: advantages and selection criteria, 2:41091 (CEA-CONF-3615)
EYES
See also RETINA
EYES/BIOLOGICAL RADIATION EFFECTS
Biological effects of laser radiation (a bibliography with abstracts). Report for 1964-Jan 1977, 2:42137 (NTIS/PS-77/0028)

F

F REGION
See also F2 LAYER
SPREAD F
F REGION/ELECTRON DENSITY
Model of equatorial scintillations from in situ measurements. Environmental research papers, 2:42175 (AD-A-027041)
Study of the conditions necessary for the onset of mid-latitude spread F, 2:42185 (N-76-29782)
F REGION/SCINTILLATIONS
Model of equatorial scintillations from in situ measurements. Environmental research papers, 2:42175 (AD-A-027041)
F2 LAYER/ELECTRON DENSITY
F_2 peak electron densities in the main trough region of the ionosphere, 2:42180 (N-76-24798)
F2 LAYER/WAVE PROPAGATION
Improving the global ionospheric predictions of f(o)F2. Air force surveys in geophysics, 2:42177 (AD-A-030741)
FAILED ELEMENT MONITORS/DESIGN
Development of the Super-Sipper in-core and out-of-core failed fuel detection systems, 2:41483
FALLOUT
(For radioactive fallout only.)
FALLOUT/RADIATION MONITORING
Appendix to health and safety laboratory environmental quarterly (Tabulated data on fallout radioactivity in environment), 2:41987 (HASL-318(App.))
Health and Safety Laboratory environmental quarterly, December 1, 1976-March 1, 1977, 2:42085 (HASL-318)
FAR INFRARED RADIATION/TECHNOLOGY ASSESSMENT
Superconductors, magnetic detectors and magnetic electronics. Final report, 2:42210 (AD-A-034361)
FARADAY CUPS/PERFORMANCE
Faraday cup with multiple internal filters and a primary current monitor for characterizing high dose pulsed electron beams. Final report, 2:41924 (AD-A-034613)
FAST BREEDER TYPE REACTORS
See FBR TYPE REACTORS
FAST FLUX TEST FACILITY REACTOR
See FFTF REACTOR
FAST REACTORS
See also FBR TYPE REACTORS
FFTF REACTOR
GCFR TYPE REACTORS
LMFBR TYPE REACTORS
FAST REACTORS/RADIOACTIVE WASTE PROCESSING
Transmutation of strontium-90 and cesium-137 in a high-flux fast reactor with a thermalized central region, 2:41460
FATTY ACIDS
See CARBOXYLIC ACIDS
FBR TYPE REACTORS
See also GCFR TYPE REACTORS
LMFBR TYPE REACTORS
FBR TYPE REACTORS/FEASIBILITY STUDIES
Considerations on the use of N_2O_4 as a cooling and working medium in nuclear power plants with fast breeder reactors, 2:41411
FBR TYPE REACTORS/FUEL CYCLE
Development of F_2 two-step fluorination process for non-aqueous reprocessing, 2:41096 (JAERI-M-6393)
FECES/RADIOMETRIC ANALYSIS
Determination of heavy elements in humans, 2:42099 (BNWL-2088)
Estimation of lung and skeletal burdens of bone-seeking radionuclides in man from in vivo scintillation measurements of the thorax and the head, 2:42107 (BNWL-2088)
FEDERAL REPUBLIC OF GERMANY
See GERMAN FEDERAL REPUBLIC
FEED MATERIALS PLANTS/RADIOACTIVE WASTE MANAGEMENT
Management and control of radioactive wastes from uranium-milling operations, 2:41125 (IAEA-CN-36/479)
Management of wastes containing radioactivity from mining and milling of uranium ores in Northern Australia, 2:41124 (IAEA-CN-36/418)
FERTILIZERS
Chemical composition and effectiveness of oil shale ash and cement kiln flue dust as liming fertilizers, 2:41069 (PB-254559-T/SL)
FERTILIZERS/BIOLOGICAL RADIATION EFFECTS
Beneficial Uses Program progress report, period ending December 31, 1976 (Gamma inactivation of microorganisms in sewage sludge), 2:42074 (SAND-77-0426)
FERTILIZERS/PRODUCTION
Coal resources for the fertilizer plant at Korba, Madhya Pradesh, 2:40868
FFTF REACTOR/FUEL ASSEMBLIES
Pressure drop measurements in FFTF fuel vibration tests, 2:41500 (HEDL-TC-812)
FFTF REACTOR/HEAT EXCHANGERS
Fluidelastic tube vibration in a heat exchanger designed for sodium-to-air operation, 2:41505
FFTF REACTOR/PIPES
Interim stress analysis report of liquid metal pipe clamp assemblies for Fast Flux Test Facility, 2:41501 (HEDL-TI-76034-6)
FFTF REACTOR/PRIMARY COOLANT CIRCUITS
Fast Flux Test Facility. Final report on FFTF outlet plenum buoyancy effects study, 2:41504 (WARD-2171-64)
FFTF REACTOR/REACTOR COMPONENTS
Liquid Metal Engineering Center (LMEC). Annual technical progress report, January-December 1976 (LMFBR sodium component and instrumentation testing), 2:41405 (LMEC-77-1)
FFTF REACTOR/REACTOR CORES
Fast Flux Test Facility. Final report on FFTF outlet plenum buoyancy effects study, 2:41504 (WARD-2171-64)
FILTERS
See also AIR FILTERS
FILTERS/COMPARATIVE EVALUATIONS
Utilization of low BTU gas from in-situ coal gasification for on-site power generation, 2:40773 (MERC/SP-76/3)
FIRES/RESEARCH PROGRAMS
Experimental coal mine fire research, 2:40912 (MERC/SP-76/3)

FIRES/SAFETY ENGINEERING
Friction loss studies using a 0.0127-m fire hose, 2:41921
FISH CULTURE
See AQUACULTURE
FISHES
See also TROUT
FISHES/PHYSIOLOGY
Physiological effects of sublethal levels of acid water on fish, 2:42122 (PB-253958)
FISHES/TEMPERATURE EFFECTS
Downstream movement of fish in a tributary of southern Lake Superior, 2:42116
FISSION FRAGMENTS/ELECTRON-ION COLLISIONS
Electron Boltzmann equation in a plasma generated by fission fragments, 2:42195 (N-76-29018)
FISSION FRAGMENTS/PLASMA PRODUCTION
Electron Boltzmann equation in a plasma generated by fission fragments, 2:42195 (N-76-29018)
FISSION PRODUCT RELEASE/RESEARCH PROGRAMS
LMFBR Aerosol Release and Transport Program. Quarterly progress report for October-December 1976, 2:41533 (ORNL/NUREG/TM-90)
FISSION PRODUCTS/TRANSMUTATION
Transmutation of strontium-90 and cesium-137 in a high-flux fast reactor with a thermalized central region, 2:41460
FLASKS
See CASKS
FLAT PLATE COLLECTORS
Method and equipment to collect and store solar energy (Patent), 2:41218
FLAT PLATE COLLECTORS/SPECTRALLY SELECTIVE SURFACES
Improvement of black nickel coatings. Final report, 2:41226 (N-76-28404)
FLOW (FLUID)
See FLUID FLOW
FLOWMETERS/DESIGN
New type sodium flow meter for fuel elements in nuclear power stations (LMFBR), 2:41415
FLOWMETERS/PERFORMANCE TESTING
Quarterly progress report on advanced two-phase instrumentation program for November-December 1976 (Water cooled reactor blowdown measurements), 2:41534 (ORNL/NUREG/TM-93)
FLUE GAS/CLEANING
Device for saving fuel and cleaning off-gas in heating installations (Patent), 2:41282
FLUE GAS/DESULFURIZATION
Desulfurization of steel mill sinter plant gases. Final report, 2:41976 (PB-261922)
New tool combats SO_2 emissions, 2:40981
Shell flue gas desulfurization process: demonstration on oil- and coal-fired boilers, 2:40851
Simplified procedures for estimating flue gas desulfurization system costs. Final report May 74-Apr 76, 2:41278 (PB-255978)
FLUID FLOW
See also TWO-PHASE FLOW
FLUID FLOW/MATHEMATICAL MODELS
Generalized theory for diffusive fluid flow through solid, permeable media, 2:40783 (MERC/SP-76/3)
FLUIDIZED-BED COMBUSTION
Fluidised combustion, 2:41176
FLUIDIZED-BED COMBUSTION/RESEARCH PROGRAMS
Coal power and combustion. Quarterly report, April-June 1976, 2:40907 (ERDA-76-94/2)
FLUIDIZED-BED COMBUSTORS/PERFORMANCE TESTING
Fluidized vortex incineration of waste. Final report May 70-Aug 74, 2:41175 (PB-258071)
FLUORIDE VOLATILITY PROCESS
Development of F_2 two-step fluorination process for non-aqueous reprocessing, 2:41096 (JAERI-M-6393)
FLUORIDE VOLATILITY PROCESS/COLD TRAPS
Adaptation of the continuous cold trap system of fluidized-bed to the fluoride volatility process, 2:41078 (JAERI-M-6405)
FLUORINE/CHEMICAL REACTIONS
Determination of absolute photon yields in chemiluminescent reactions. Annual technical report, 3 Dec 1975-2 Dec 1976, 2:41872 (AD-A-034515)
FLUX CORED ARC WELDING
See ARC WELDING
FLY ASH/BIOLOGICAL EFFECTS
Fractionator for size-classification of aerosolized solid particulate matter (Sample preparation for biological testing), 2:42119 (UCD-472-123)
Morphology and chemistry of size-classified fly ash collected from the stack of a coal-fired power plant, 2:42120 (UCD-472-123)
FLY ASH/CHEMICAL COMPOSITION
Morphology and chemistry of size-classified fly ash collected from the stack of a coal-fired power plant, 2:42120 (UCD-472-123)
FLY ASH/PARTICLE SIZE
Collaborative efforts in the characterization of stack-collected fly ash, 2:41983 (UCD-472-123)
Morphology and chemistry of size-classified fly ash collected from the stack of a coal-fired power plant, 2:42120 (UCD-472-123)
FLY ASH/QUANTITATIVE CHEMICAL ANALYSIS
Collaborative efforts in the characterization of stack-collected fly ash, 2:41983 (UCD-472-123)
FLY ASH/SAMPLE PREPARATION
Fractionator for size-classification of aerosolized solid particulate matter (Sample preparation for biological testing), 2:42119 (UCD-472-123)
FLY ASH/STABILITY
Technology for using sulfate waste in highway construction. Final report, 2:40850 (PB-254815)
FLY ASH/TOXICITY
Development of the chick myoblast culture system for the study of toxicity of fly ash, 2:42121 (UCD-472-123)
FLYWHEEL ENERGY STORAGE/FEASIBILITY STUDIES
Energy storage: feasibility study to collect, store and release energy from solar origin, using a kinetic battery stockage, 2:41565 (N-76-27695)
FOOD
See also ANIMAL FEEDS
MEAT
MILK
FOOD/RADIOACTIVITY
Appendix to health and safety laboratory environmental quarterly (Tabulated data on fallout radioactivity in environment), 2:41987 (HASL-318(App.))
FOREST LITTER/DECOMPOSITION
Decomposition in freshwater, 2:42004
FORT ST. VRAIN REACTOR
See VRAIN REACTOR
FORTISSIMO REACTOR
See RAPSODIE REACTOR
FOSSIL-FUEL POWER PLANTS
Existing and proposed fuel conversion facilities. Summary (Colorado, Montana, S. Dakota, N. Dakota, Utah, Wyoming), 2:41248 (PB-258264)
FOSSIL-FUEL POWER PLANTS/AIR POLLUTION CONTROL
Clean use of coal at the Hadera power station, 2:41280
FOSSIL-FUEL POWER PLANTS/BOILER FUEL
Implementing coal utilization provisions of Energy Supply and Environmental Coordination Act, 2:41640 (PB-255855)
Technical evaluation study: solid waste as a fuel at Ft. Bragg, N. C. Final report, 2:41174 (AD-A-034416)
FOSSIL-FUEL POWER PLANTS/CHEMICAL EFFLUENTS
PBL structure: the Sangamon Experiment of 1975 (Physical mechanisms for regional air pollution in Illinois), 2:41951 (ANL-75-60(Pt.4))
FOSSIL-FUEL POWER PLANTS/COMPARATIVE EVALUATIONS
Nuclear power plants: an alternative for large cities, 2:41443
FOSSIL-FUEL POWER PLANTS/CONSTRUCTION
Changes in an electric utility's fuel base, 2:41653
FOSSIL-FUEL POWER PLANTS/COST
Monte Carlo error analysis of power plant capital cost calculations, 2:41440 (K/CSD-3)
FOSSIL-FUEL POWER PLANTS/ENERGY SUPPLIES
Impact of natural gas curtailments on electric utility plants. Volume I. Text, 2:41033 (PB-258 329)
Impact of natural gas curtailments on electric utility plants. Volume II. Schedules, 2:41035 (PB-258330)
FOSSIL-FUEL POWER PLANTS/ENVIRONMENTAL EFFECTS
Application of a lagrangian statistical trajectory model to the simulation of sulfur pollution over the northeastern United States, 2:41958 (ANL-75-60(Pt.4))
Investigation of size-dependent concentration of trace elements in aerosols emitted from the oil-fired heating plants, 2:40986 (N-76-27720)
PBL structure: the Sangamon Experiment of 1975 (Physical mechanisms for regional air pollution in Illinois), 2:41951 (ANL-75-60(Pt.4))
FOSSIL-FUEL POWER PLANTS/FLUE GAS
Comparative U.S./USSR tests of a hot-side electrostatic precipitator. Final report, Jan 1975-Sep 1976, 2:41279 (PB-261918)
FOSSIL-FUEL POWER PLANTS/GAS TURBINES
Calculation of flame tube temperature of a multiregister combustion chamber, made by Nevskii Engineering Works, with a swirl mixer, 2:41264
FOSSIL-FUEL POWER PLANTS/GASEOUS WASTES
Application of a lagrangian statistical trajectory model to the simulation of sulfur pollution over the northeastern United States, 2:41958 (ANL-75-60(Pt.4))

FOSSIL-FUEL POWER PLANTS/HEALTH HAZARDS
Annual report, fiscal year 1976, 2:42118 (UCD-472-123)
Collaborative efforts in the characterization of stack-collected fly ash, 2:41983 (UCD-472-123)
Development of the chick myoblast culture system for the study of toxicity of fly ash, 2:42121 (UCD-472-123)
Fractionator for size-classification of aerosolized solid particulate matter (Sample preparation for biological testing), 2:42119 (UCD-472-123)
Health effects of pollutants associated with fossil-fuel power generation (Metabolism and health effects of pollutants in man and laboratory animals), 2:40862 (UCD-472-123)
Morphology and chemistry of size-classified fly ash collected from the stack of a coal-fired power plant, 2:42120 (UCD-472-123)
Synthesis of ^{13}N- and ^{38}S-labeled fossil fuel power plant effluents for in vivo distribution studies, 2:42125 (UCD-472-123)
FOSSIL-FUEL POWER PLANTS/OFFSHORE SITES
High voltage dc transmission applications offshore, 2:41297
FOSSIL-FUEL POWER PLANTS/PLUMES
Use of LARS system for the quantitative determination of smoke plume lateral diffusion coefficients from ERTS images of Virginia, 2:41962 (N-76-24681)
FOSSIL-FUEL POWER PLANTS/POLLUTION CONTROL EQUIPMENT
Simplified procedures for estimating flue gas desulfurization system costs. Final report May 74-Apr 76, 2:41278 (PB-255978)
FOSSIL-FUEL POWER PLANTS/POWER GENERATION
Changes in an electric utility's fuel base, 2:41653
FOSSIL-FUEL POWER PLANTS/POWER TRANSMISSION
High voltage dc transmission applications offshore, 2:41297
FOSSIL-FUEL POWER PLANTS/SITE SELECTION
Site selection of lignite-fed power plants based on fuel supplies, 2:41284
FOSSIL-FUEL POWER PLANTS/STACKS
Feasibility of a single tall stack in power plant construction. Final report, 2:41277 (PB-255952)
FOSSIL-FUEL POWER PLANTS/THERMAL EFFLUENTS
Stratified flows produced upon discharge of hot power-plant effluents into cooling ponds and rivers, 2:41498
FTR REACTOR
See FFTF REACTOR
FUEL ASSEMBLIES
See also FUEL ELEMENT CLUSTERS
FUEL ASSEMBLIES/DESIGN
Core engineering sixtieth quarterly report, August-October 1976 (LMFBR; FFTF), 2:41385 (GEAP-10028-60)
FUEL ASSEMBLIES/HEAT TRANSFER
Heat transfer tests of an electrically heated 7-rod mock-up of an LMFBR radial blanket assembly, 2:41421
FUEL BUNDLES
See FUEL ELEMENT CLUSTERS
FUEL CANS/TEMPERATURE MEASUREMENT
Irradiation temperature memorization bt retention of krypton-85. Application to the temperature determination for the internal cladding surface of fuel elements in PWR, 2:41327 (CEA-R-4798)
FUEL CELLS
See also ACID ELECTROLYTE FUEL CELLS
ALCOHOL FUEL CELLS
HYDROCARBON FUEL CELLS
Coal technology program progress report for February 1977, 2:40732 (ORNL/TM-5858)
FUEL CELLS/POWER TRANSMISSION
Space shuttle engineering and operations support. Orbiter to spacelab electrical power interface. Avionics system engineering, 2:41665 (N-76-28340)
FUEL COOLING INSTALLATIONS
See SPENT FUEL STORAGE
FUEL CYCLE
See also FUEL MANAGEMENT
PLUTONIUM RECYCLE
Fuel cycle of the LWR system in the Federal Republic of Germany, 2:41111 (IAEA-CN-36/95)
Physical characteristics of fast power reactor fuel and their effect on the fuel cycle (LMFBR), 2:41396 (IAEA-CN-36/326)
PWR and BWR light water reactor systems in the USA and their fuel cycle, 2:41319 (IAEA-CN-36/566)
Significant actinide and daughter activities from the HTGR fuel cycle, 2:41362 (PB-258150)
FUEL ELEMENT CLUSTERS/HYDRODYNAMICS
Local hydrodynamic characteristics of regular triangular lattice of rods, 2:41458 (UJV-3778-R)
FUEL ELEMENT CLUSTERS/PRESSURE DROP
Laminar-flow pressure drop in symmetrical finite, rod bundles, 2:41464
FUEL ELEMENT CLUSTERS/TURBULENT FLOW
Turbulent temperature and pressure pulsations in longitudinal flow through rod bundles, 2:41453 (CS-INIS-30)
FUEL ELEMENT FAILURE/SIMULATION
Experimental investigations of the power ramp failure propensity of LWR fuel, 2:41520 (IAEA-CN-36/279)
FUEL ELEMENTS
See also FUEL ASSEMBLIES
FUEL CANS
FUEL PINS
FUEL RODS
SPENT FUEL ELEMENTS
Gas-cooled fast breeder reactor. Quarterly progress report, November 1, 1976-January 31, 1977, 2:41384 (GA-A-14240)
FUEL ELEMENTS/DEFORMATION
Evaluation of in-reactor measurements of fuel rod deformations, 2:41488 (IAEA-CN-36/495)
FUEL ELEMENTS/DESIGN
Advanced LMFBR core design. Fifth quarterly report, July-September 1976, 2:41387 (GEAP-14078-5)
Fast reactor fuel design and development (LMFBR), 2:41391 (IAEA-CN-36/64)
Italian progress on LWR fuel design, manufacturing, testing and management, 2:41331 (IAEA-CN-36/310)
Work carried out in France on the design, manufacture, handling and development of nuclear fuel (PWR), 2:41334 (IAEA-CN-36/569)
FUEL ELEMENTS/FABRICATION
Fabrication of nuclear fuel elements in Mexico, 2:41087 (IAEA-CN-36/540)
Fabrication and irradiation performance of French HTGR fuel (Enriched uranium and thorium), 2:41084 (IAEA-CN-36/270)
Integrated planning for a fuel industry with emphasis on minimum size to fabricate own fuel, 2:41086 (IAEA-CN-36/386)
Nuclear fuel in water reactors: manufacturing technology operational experience and development activities in the Federal Republic of Germany, 2:41083 (IAEA-CN-36/103)
Status of the development of mixed oxide fuels in PNC, 2:41489 (IAEA-CN-36/553)
FUEL ELEMENTS/PERFORMANCE
CANDU fuel: fifteen years of power reactor experience, 2:41368 (IAEA-CN-36/184)
Fuel performance in Babcock and Wilcox pressurized water reactors, 2:41346
Fuel reliability in light water reactors, experience and assessment for the future, 2:41316 (IAEA-CN-36/474)
HTGR fuel and fuel cycle technology, 2:41359 (IAEA-CN-36/578)
Performance and reliability of LWR fuel, 2:41317 (IAEA-CN-36/475)
FUEL ELEMENTS/PERFORMANCE TESTING
Fabrication and irradiation performance of French HTGR fuel (Enriched uranium and thorium), 2:41084 (IAEA-CN-36/270)
HTGR fuels and core development program. Quarterly progress report for the period ending February 28, 1977, 2:41355 (GA-A-14298)
Performance evaluation of UO_2-Zr fuel in power ramp tests, 2:41487 (IAEA-CN-36/203)
FUEL ELEMENTS/RADIOCHEMICAL ANALYSIS
Radiochemical evaluation of Babcock and Wilcox's commercial pressurized water reactor fuel performance, 2:41347
FUEL FABRICATION PLANTS/PERSONNEL MONITORING
Measurement of transuranic elements in vivo at CRNL (Personnel monitoring at nuclear fuel fabrication plant), 2:42103 (BNWL-2088)
FUEL FABRICATION PLANTS/SAFETY
Numerical simulation of tornado-borne missile impact on fuel reprocessing and fabrication plants, 2:41881 (UCRL-52223)
FUEL FEEDING SYSTEMS/EVALUATION
Research and development of rapid hydrogenation for coal conversion to synthetic motor fuels (Riser Cracking of Coal). Third Quarter Report, October 1-December 31, 1976, 2:40794 (FE-2307-13)
FUEL FEEDING SYSTEMS/RESEARCH PROGRAMS
Coal power and combustion. Quarterly report, April-June 1976, 2:40907 (ERDA-76-94/2)
FUEL GAS
See also HIGH BTU GAS
INTERMEDIATE BTU GAS
LOW BTU GAS
PRODUCER GAS
FUEL GAS/CALORIFIC VALUE
Status of the Linked Vertical Well process in underground coal gasification, 2:40772 (MERC/SP-76/3)
Theoretical analysis of Soviet in situ coal gasification field tests, 2:40766 (MERC/SP-76/3)
FUEL GAS/CHEMICAL COMPOSITION
Economic comparison of producing SNG by Lawrence Livermore Laboratory's in situ coal gasification process with Lurgi aboveground coal gasification, 2:40758 (MERC/SP-76/3)
Monitoring of emissions from an in situ coal gasification experiment (Hanna Experiment), 2:40762 (MERC/SP-76/3)

Status of the Linked Vertical Well process in underground coal gasification, 2:40772 (MERC/SP-76/3)
Theoretical analysis of Soviet in situ coal gasification field tests, 2:40766 (MERC/SP-76/3)
FUEL GAS/PURIFICATION
Coal technology program progress report for January 1977, 2:40731 (ORNL/TM-5819)
FUEL MANAGEMENT/MATHEMATICAL MODELS
Solution of the fuel burnup control problem with a controlling neutron equation and Walsh functions, 2:41461
FUEL MANAGEMENT/NEUTRON SLOWING-DOWN THEORY
Critical experiments and analysis twenty-first quarterly report, October-December 1976 (LMFBR), 2:41386 (GEAP-13771-21)
FUEL MANAGEMENT/OPTIMIZATION
Simulation methods for nuclear production scheduling, 2:41446
FUEL OILS
See also HEATING OILS
RESIDUAL FUELS
FUEL OILS/COMBUSTION PRODUCTS
Compilation of air pollutant emission factors. Supplement Number 6. Second edition, 2:41989 (PB-254274)
FUEL OILS/DESULFURIZATION
Preliminary environmental assessment of the CAFB. Final report, Aug 1975-May 1976, 2:40979 (PB-262001)
FUEL OILS/GASIFICATION
Preliminary environmental assessment of the CAFB. Final report, Aug 1975-May 1976, 2:40979 (PB-262001)
FUEL OILS/MARKET
Weekly petroleum statistics reports, 1974-1975, 2:40978 (PB-255920)
FUEL OILS/SYNTHESIS
Production of hydrocarbon-type synthetic fuel from wood, 2:41171 (AD-A-034359)
FUEL PELLETS/MELTDOWN
Mechanical response of UO_2 subjected to transient heating (LMFBR), 2:41556
FUEL PELLETS/THERMAL STRESSES
Mechanical response of UO_2 subjected to transient heating (LMFBR), 2:41556
FUEL PINS/PERFORMANCE
Behaviour of mixed monocarbide and -nitride fuel under high power density (LMFBR), 2:41399 (IAEA-CN-36/369)
FUEL POOLS/SAFETY
Criticality control and long term storage of spent fuel, 2:41105 (IAEA-CN-36/33)
FUEL REPROCESSING PLANTS
Reprocessing of fission material: a look at the European situation, 2:41102
FUEL REPROCESSING PLANTS/CRITICALITY
Use of neutron poisons for criticality safety in reprocessing plants, 2:41103
FUEL REPROCESSING PLANTS/EQUIPMENT
Plant for the liquid-liquid extraction of radioactive substances (Patent), 2:41100
FUEL REPROCESSING PLANTS/FISSION PRODUCT RELEASE
^{129}I as an example: problems of reprocessing, 2:41101
FUEL REPROCESSING PLANTS/NUCLEAR MATERIALS DIVERSION
Overall probability of detection in connection with the optimization of safeguards effort, 2:41146
FUEL REPROCESSING PLANTS/RADIOACTIVE EFFLUENTS
Effluent and sanitary sewer monitors, 2:42013 (LA-6638-M)
FUEL REPROCESSING PLANTS/RADIOACTIVE WASTE DISPOSAL
Development of methods for solidification and disposal of fuel cycle radioactive wastes, 2:41122 (IAEA-CN-36/350)
Discharge into the atmosphere of volatile fission products from nuclear power stations and fuel reprocessing plants and the perspectives of their retention, 2:41132 (IAEA-CN-36/317)
FUEL REPROCESSING PLANTS/RADIOACTIVE WASTE MANAGEMENT
Management of high level radioactive waste, 2:41119 (IAEA-CN-36/226)
FUEL REPROCESSING PLANTS/SAFETY
Numerical simulation of tornado-borne missile impact on fuel reprocessing and fabrication plants, 2:41881 (UCRL-52223)
FUEL RODS/MECHANICAL VIBRATIONS
Fuel rods vibration in fast breeder reactors, 2:41382 (CS-INIS-29)
FUEL-CLADDING INTERACTIONS/STRAINS
Fuel-cladding mechanical interaction effects in fast reactor mixed oxide fuel, 2:41408 (WARD-OX-3045-28)
FUEL-CLADDING INTERACTIONS/STRESSES
Fuel-cladding mechanical interaction effects in fast reactor mixed oxide fuel, 2:41408 (WARD-OX-3045-28)
FUEL-COOLANT INTERACTIONS/HEAT TRANSFER
Stability of a submerged frozen crust (LMFBR), 2:41552
FUELS
See also AUTOMOTIVE FUELS
AVIATION FUELS
FUEL GAS
HYDROGEN FUELS
JET ENGINE FUELS
REFUSE DERIVED FUELS
SOLVENT-REFINED COAL
THERMONUCLEAR FUELS
FUELS/CLASSIFICATION
Classification of petroleum-derived fuels, 2:40961
FUELS/DESULFURIZATION
Thermal stability of sulfur compounds in heavy petroleum residual stocks, 2:40980
FUELS/THERMODYNAMIC PROPERTIES
Thermal stability of sulfur compounds in heavy petroleum residual stocks, 2:40980
FUMES
See AEROSOLS
FUNCTIONS
See also PARTITION FUNCTIONS
FUNCTIONS/SERIES EXPANSION
Angular overconvergence for rational functions converging geometrically on (0, + infinity), 2:42336
FUNGI/ECOLOGY
Decomposition in freshwater, 2:42004
FUSED SALTS
See MOLTEN SALTS
FUSION REACTORS
See THERMONUCLEAR REACTORS

G

GADOLINIUM PERCHLORATES/OSMOSIS
Isopiestic determination of the activity coefficients of some aqueous rare earth electrolyte solutions at 25°C. II. The rare earth perchlorates, 2:41874
GADOLINIUM PERCHLORATES/THERMODYNAMIC PROPERTIES
Heats of dilution of some aqueous rare earth electrolyte solutions at 25°C. I. Rare earth perchlorates, 2:41873
GALLIUM ALLOYS/CRYSTAL-PHASE TRANSFORMATIONS
Kinetics of the delta to alpha transformation in plutonium rich Pu-Ga alloys, 2:41774
GALLIUM ALLOYS/ELASTICITY
Single-crystal elastic constants of a plutonium-gallium alloy, 2:41792
GALLIUM ALLOYS/ELECTRIC CONDUCTIVITY
Investigation of some magnetic and electric properties of compounds in the U-Ga system and of the U_3As_4 compound, 2:41803
GALLIUM ALLOYS/MAGNETIC SUSCEPTIBILITY
Investigation of some magnetic and electric properties of compounds in the U-Ga system and of the U_3As_4 compound, 2:41803
GALLIUM ALLOYS/PHASE DIAGRAMS
Some results of a study of the Pu-Al-Ga phase diagram, 2:41765
GALLIUM ALLOYS/SOLID SOLUTIONS
Splat cooling of some actinide alloys, 2:41760
GALLIUM ALLOYS/SPLAT COOLING
Splat cooling of some actinide alloys, 2:41760
GALLIUM ALLOYS/TENSILE PROPERTIES
Effect of strain rate on the tensile properties of α- and delta-stabilized plutonium, 2:41788
GALLIUM ALLOYS/THERMAL DIFFUSIVITY
Heat transport properties of a delta-stabilized Pu-1 wt.% Ga alloy from room temperature to 500 degrees C, 2:41800
GALLIUM ARSENIDE SOLAR CELLS/FABRICATION
High-efficiency thin-film GaAs solar cells. Interim report No. 2, 1 Apr-30 Jun 76, 2:41191 (PB-258493)
GALLIUM ARSENIDE SOLAR CELLS/OPTIMIZATION
The optimization of Ga(1-x)Al(x)As-GaAs solar cells for air mass zero operation and a study of Ga(1-x)Al(x)As-GaAs solar cells at high temperatures, Phase 1. Final report, 2:41186 (N-76-28645)
GALLIUM ARSENIDES/PHOTOCONDUCTIVITY
Photoelectrolytic production of hydrogen using semiconductor electrodes. Interim report, 2:41160 (N-76-24374)
GAMMA DETECTION/SCINTILLATION COUNTERS
Low fluxes of x rays. Final report (Interactions of high-energy protons with spacecraft materials and typical materials for scintillation detectors), 2:41936 (N-76-30279)

GAMMA FUEL SCANNING
In-pile gamma scanning. Application to power and burnup measurement and to the study of fission product migration, 2:41486 (CEA-CONF-3663)
GAMMA HEATING
See RADIATION HEATING
GAMMA RADIATION/ENERGY SPECTRA
FLAIR: a scaling and folding code for the generation of photon transport results in air. Final report, 2:42208 (AD-A-034754)
GAS BLANKETS
A note on the problems of plasma-neutral gas interaction, 2:42236 (N-76-31018)
GAS COOLED FAST BREEDER REACTOR
See GCFR REACTOR
GAS COOLED FAST BREEDER REACTORS
See GCFR TYPE REACTORS
GAS COOLED REACTORS
See also GCFR REACTOR
GCFR TYPE REACTORS
HTGR TYPE REACTORS
GAS COOLED REACTORS/FEASIBILITY STUDIES
Considerations on the use of N_2O_4 as a cooling and working medium in nuclear power plants with fast breeder reactors, 2:41411
GAS ENGINES
See INTERNAL COMBUSTION ENGINES
GAS FUELED REACTORS
Plasma core reactor simulations using RF uranium seeded argon discharges, 2:41454 (N-76-30046)
GAS LASERS
See also CARBON DIOXIDE LASERS
GAS LASERS/FEASIBILITY STUDIES
Analytic modeling of electrically excited D_2/HCl and HCl laser experiments. Final report, 1 Aug 1974-31 May 1976, 2:41897 (AD-A-034674)
GAS LASERS/OPERATION
Excitation efficiency and energy storage capabilities of high pressure rare gas-metal vapor mixtures. Final report, 2:41900 (COO-2790-2)
Rare gas monohalide discharge studies. Final report, 2:41908 (UCRL-13713)
GAS LASERS/PERFORMANCE
Effect of the addition of SF_6 to a N_2 electrical discharge laser, 2:41914
Effects of oxygen contamination on gas dynamic laser performance, 2:41899 (AD-A-034900)
GAS LASERS/REVIEWS
Combustion driven cw high power lasers, 2:41903 (N-76-24562)
GAS LASERS/STIMULATED EMISSION
Superradiative rare gas halide lasers excited by electric discharge, 2:41915
GAS OILS/CATALYTIC CRACKING
Diffusion effects in catalytic gas oil cracking, 2:40955
Effects of diffusion resistance on gasoline selectivity in catalytic cracking, 2:40954
Hydrocracking of residual oils and tars. II. The catalytic hydrocracking of Athabasca bitumen, 2:41060
Theoretical interpretation of gas oil selectivity data on x-sieve catalyst, 2:40956
GAS OILS/CORROSIVE EFFECTS
Microbiological corrosion of tanks in long-term storage of gas oil, 2:41028
GAS OILS/DESULFURIZATION
Comparison of bottom-feed and top-feed reaction systems for hydrodesulphurization, 2:41058
Hydrodesulphurization of heavy gas-oils (650-975°F) derived from Athabasca bitumen, 2:41057
GAS OILS/HYDROCRACKING
Hydrocracking of residual oils and tars. II. The catalytic hydrocracking of Athabasca bitumen, 2:41060
GAS OILS/STORAGE FACILITIES
Microbiological corrosion of tanks in long-term storage of gas oil, 2:41028
Microbiological corrosion of tanks in long-term storage of gas oil. II. Further bacterial studies and use of borax as a biocide, 2:41029
GAS SCINTILLATION DETECTORS/PERFORMANCE
Gas scintillation proportional counter for x-ray astronomy, 2:41928 (N-76-27550)
GAS TURBINES
Coal technology program progress report for February 1977, 2:40732 (ORNL/TM-5858)
Utilization of low BTU gas from in-situ coal gasification for on-site power generation, 2:40773 (MERC/SP-76/3)
GAS TURBINES/COMBUSTION KINETICS
Calculation of flame tube temperature of a multiregister combustion chamber, made by Nevskii Engineering Works, with a swirl mixer, 2:41264
GAS TURBINES/DESIGN
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
GAS TURBINES/THERMODYNAMIC CYCLES
Thermodynamic cycles and elemental efficiencies, 2:41261
GASBUGGY EVENT
Effects of heat and radiation on Gasbuggy chimney gas, 2:41039
Gas quality and geochemical studies in gas-stimulation experiments, 2:41040
GASEOUS WASTES
See also EXHAUST GASES
FLUE GAS
OFF-GAS SYSTEMS
GASEOUS WASTES/ENVIRONMENTAL EFFECTS
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
GASEOUS WASTES/ENVIRONMENTAL TRANSPORT
Hybrid computer program for rapidly solving flowing or static chemical kinetic problems involving many chemical species, 2:41963 (N-76-29382)
Puff-on-cell model for computing pollutant transport and diffusion, 2:41959 (ANL-75-60(Pt.4))
GASEOUS WASTES/STACK DISPOSAL
Application of a lagrangian statistical trajectory model to the simulation of sulfur pollution over the northeastern United States, 2:41958 (ANL-75-60(Pt.4))
GASEOUS WASTES/TRAJECTORIES
Application of a lagrangian statistical trajectory model to the simulation of sulfur pollution over the northeastern United States, 2:41958 (ANL-75-60(Pt.4))
GASOLINE/ANTIKNOCK RATINGS
Catalytic reforming of hydrogenated shale-oil naphtha, 2:41054
GASOLINE/CHARGES
Selling prices and taxes on motor gasoline, diesel fuel, and heating oil in selected countries, as of October 1974. International economics report 1974, 2:40975 (PB-254943)
GASOLINE/CHEMICAL REACTION YIELD
Effects of diffusion resistance on gasoline selectivity in catalytic cracking, 2:40954
GASOLINE/MARKET
Weekly petroleum statistics reports, 1974-1975, 2:40978 (PB-255920)
GASOLINE/PHYSICAL PROPERTIES
Curtailment of time required to determine gasoline induction period, 2:40964
GASOLINE/PRODUCTION
Mathematical description of the hydrocracking of distillates from the liquid-phase hydrogenation of coal, 2:40744
GASOLINE/STABILITY
Curtailment of time required to determine gasoline induction period, 2:40964
GASOLINE/TAXES
Selling prices and taxes on motor gasoline, diesel fuel, and heating oil in selected countries, as of October 1974. International economics report 1974, 2:40975 (PB-254943)
GCFR REACTOR/FUEL ELEMENTS
Gas-cooled fast breeder reactor. Quarterly progress report, November 1, 1976-January 31, 1977, 2:41384 (GA-A-14240)
GCFR REACTOR/PRIMARY COOLANT CIRCUITS
Gas-cooled fast breeder reactor. Quarterly progress report, November 1, 1976-January 31, 1977, 2:41384 (GA-A-14240)
GCFR REACTOR/REACTOR CORES
Analysis of a fuel-pin neutron-streaming experiment to test methods for calculating neutron damage to the GCFR grid plate, 2:41379 (CONF-770401-6)
Gas-cooled fast breeder reactor. Quarterly progress report, November 1, 1976-January 31, 1977, 2:41384 (GA-A-14240)
GCFR REACTOR/REACTOR KINETICS
Gas-cooled fast breeder reactor. Quarterly progress report, November 1, 1976-January 31, 1977, 2:41384 (GA-A-14240)
GCFR REACTOR/REACTOR SAFETY
Gas-cooled fast reactor safety, 2:41513 (IAEA-CN-36/36)
Gas-cooled fast breeder reactor. Quarterly progress report, November 1, 1976-January 31, 1977, 2:41384 (GA-A-14240)
Gas-cooled fast breeder reactor accident initiation and progression analysis. Progress report, July 1, 1975-June 30, 1976, 2:41510 (GA-A-14079)
GCFR REACTOR/RESEARCH PROGRAMS
Gas-cooled fast breeder reactor. Quarterly progress report, November 1, 1976-January 31, 1977, 2:41384 (GA-A-14240)
GCFR REACTOR/SHIELDING
Analysis of a fuel-pin neutron-streaming experiment to test methods for calculating neutron damage to the GCFR grid plate, 2:41379 (CONF-770401-6)
Gas-cooled fast breeder reactor shielding benchmark calculation, 2:41383 (GA-A-14236)
Gas-cooled fast breeder reactor. Quarterly progress report, November 1, 1976-January 31, 1977, 2:41384 (GA-A-14240)

GCFR TYPE REACTORS/PLANNING
Basic performance problems and prospects for 1200-1500 Mw gas-cooled fast reactors with the dissociating coolant, 2:41397 (IAEA-CN-36/332)
Need for high performance breeder reactors, 2:41402 (IAEA-CN-36/478)
GCFR TYPE REACTORS/REACTOR SAFETY
Physical and technical aspects of nuclear and chemical safety of APS with fast reactors cooled with N_2O_4, 2:41521 (IAEA-CN-36/322)
GCFR TYPE REACTORS/RHR SYSTEMS
Reliability analysis of the decay heat removal system of a 1000-MW(e) gas-cooled fast breeder reactor, 2:41425
GE STANDARD REACTOR
(Prior to 1975, BWR/6 TYPE REACTORS was used.)
GE STANDARD REACTOR/SPECIFICATIONS
Standard technical specifications for General Electric boiling water reactors, 2:41436 (PB-258385)
GENERAL ELECTRIC STANDARD REACTOR
See GE STANDARD REACTOR
GENERATORS (STEAM)
See STEAM GENERATORS
GENES/BIOLOGICAL EVOLUTION
Evolution of 5S ribosomal RNA genes in the chromosomes of the virilis group of Drosophila (^{125}I tracer techniques), 2:42049
GENES/CONTROL
Gene control mechanisms and their possible bearing on the neutralist-selectionist controversy, 2:42046
GENETICS/BIOLOGICAL MODELS
Gene control mechanisms and their possible bearing on the neutralist-selectionist controversy, 2:42046
GEOMAGNETIC FIELD/MAGNETIC RIGIDITY
Summary of cutoff rigidities calculated with the International Geomagnetic Reference Field for various epochs. Environmental research papers, 2:42148 (AD-A-028978)
GEOMAGNETIC FIELD/TABLES
Solar-geophysical data number 387. Part I. Prompt reports. Data for October 1976-September 1976. Explanation of data reports issued as number 378 (supplement) February 1976, 2:42171 (PB-263008)
GEOMAGNETIC STORMS
See MAGNETIC STORMS
GEORGIA/AIR QUALITY
Area source emission inventory: Hamilton County, Tennessee, and Walker and Catoosa Counties, Georgia. Volume I, 2:41973 (PB-258137)
Area source emission inventory: Hamilton County, Tennessee, and Walker and Catoosa Counties, Georgia. Volume II, 2:41974 (PB-258138)
GEORGIA/STATIONARY POLLUTANT SOURCES
Area source emission inventory for Dougherty County, Georgia. Volume I, 2:41969 (PB-256004)
GEOTHERMAL ENERGY CONVERSION/BINARY-FLUID SYSTEMS
Direct contact heat exhangers in geothermal power production, 2:41238
GEOTHERMAL ENERGY CONVERSION/HEAT EXCHANGERS
Direct contact heat exhangers in geothermal power production, 2:41238
GEOTHERMAL FLUIDS/CORROSIVE EFFECTS
Materials problems associated with the development of geothermal energy resources, 2:41240 (PB-254990)
GEOTHERMAL FLUIDS/SCALING
Materials problems associated with the development of geothermal energy resources, 2:41240 (PB-254990)
GEOTHERMAL SPACE HEATING/ECONOMICS
Investigation of the technical and economical feasibility of using low temperature geothermal sources in Colorado, 2:41237
GEOTHERMAL SPACE HEATING/FEASIBILITY STUDIES
Investigation of the technical and economical feasibility of using low temperature geothermal sources in Colorado, 2:41237
GEOTHERMAL WELLS/PIPES
Design of an insulated coaxial pipe assembly for a drilled geothermal wall, 2:41239
GERMAN FEDERAL REPUBLIC/NATURAL GAS INDUSTRY
Gas industry development in Federal Republic of Germany in 1975, 2:41036
GERMAN FEDERAL REPUBLIC/NUCLEAR POWER PLANTS
New nuclear power plants in the German Federal Republic. Part 1 of a report on nuclear power plant projects in Europe, 2:41300 (CS-INIS-26)
GERMAN FEDERAL REPUBLIC/RADIOACTIVE WASTE MANAGEMENT
Waste management in the Federal Republic of Germany: a survey of policy and research and development, 2:41114 (IAEA-CN-36/98)
GERMAN FEDERAL REPUBLIC/REACTOR SAFETY
Recommendations of the Reactor Safety Commission, 1971-1974, 2:41434 (PB-254804-T/SL)
GERMANY (FEDERAL REPUBLIC)
See GERMAN FEDERAL REPUBLIC
GIANT CELLS
See TUMOR CELLS
GLASS/SPECTRALLY SELECTIVE SURFACES
Cadmium stannate selective optical films for solar energy applications. Final report, 1 Jul 1973-31 Aug 1976, 2:41228 (PB-261850)
GLIOBLASTOMAS
See NEOPLASMS
GLYCOLS
Complex esters as antiwear agents, 2:41004
GOLD/DEUTERON REACTIONS
Proton sputtering. Final report (500 eV to 8 keV), 2:42318 (ORO-3557-15)
GOLD/PHYSICAL RADIATION EFFECTS
Fusion power program. Quarterly progress report, October-December 1976, 2:42314 (ANL/FPP-76-6)
GOLD/PROTON REACTIONS
Proton sputtering. Final report (500 eV to 8 keV), 2:42318 (ORO-3557-15)
GOLD/SPUTTERING
Proton sputtering. Final report (500 eV to 8 keV), 2:42318 (ORO-3557-15)
GRANULOCYTES
See LEUKOCYTES
GRAPHITE
See also PYROLYTIC CARBON
GRAPHITE/MECHANICAL PROPERTIES
Advanced composites: mechanical properties and hardware programs for selected resin matrix materials (Boron and graphite fiber reinforcement), 2:41860 (N-76-24364)
Estimate of low-Z materials for the first wall of JT-60, 2:42317 (JAERI-M-6432)
GRAPHITE/PHYSICAL PROPERTIES
Estimate of low-Z materials for the first wall of JT-60, 2:42317 (JAERI-M-6432)
GRAPHITE/PHYSICAL RADIATION EFFECTS
Carbon ribbon gauge for electron beam diagnostics. Final report, 2:41926 (AD-A-026905)
HTGR fuels and core development program. Quarterly progress report for the period ending February 28, 1977, 2:41355 (GA-A-14298)
GRAPHITE/RADIOACTIVATION
Low activation materials assessment for fusion reactors, 2:42315 (EPRI-ER-328-SR)
GRAPHITE/TENSILE PROPERTIES
HTGR fuels and core development program. Quarterly progress report for the period ending February 28, 1977, 2:41355 (GA-A-14298)
Nonlinear analysis of laminated fibrous composites (Boron/epoxy, graphite/epoxy, borsic-aluminum), 2:41861 (N-76-27359)
GREAT BRITAIN
See UNITED KINGDOM
GREENHOUSES/SOLAR SPACE HEATING
Solar energy applications in agriculture: potential, research needs, and adoption strategies, summary and recommendations, 2:41217 (PB-255928)
GRIDS/DESIGN
Gas distributor grids for high-temperature processes in fluidized bed, 2:40946
GROUND DISPOSAL
See UNDERGROUND DISPOSAL
GROUND WATER
Soil and ground water considerations (Earth-covered construction), 2:41594 (NSF-RA-760006)
GROUND WATER/ELECTROMAGNETIC SURVEYS
Application of electromagnetic frequency sounding to groundwater problems, 2:42144
GROUND WATER/GEOCHEMISTRY
Recent surface movements in the Baldwin Hills, Los Angeles County, California, 2:40937
GROUND WATER/WATER POLLUTION
Groundwater contamination from in-situ coal gasification: laboratory studies, 2:40854 (MERC/SP-76/3)
Preliminary laboratory and modeling studies on the environmental impact of 'in-situ' coal gasification, 2:40753 (MERC/SP-76/3)
GROUND WATER/WATER QUALITY
Hydrogeologic assessment of an underground coal gasification project site Grant District, Wettzel County, W. Va., 2:40855 (MERC/SP-76/3)
Monitoring groundwater quality: monitoring methodology. Final report, 2:42010 (PB-256068)
GULF GENERAL ATOMIC FAST BREEDER REACTOR
See GCFR REACTOR

H

HADDAM NECK REACTOR
See CONNECTICUT YANKEE REACTOR
HAEMOPHILUS/MUTATIONS
Reversions of two proline-requiring auxotrophs of Haemophilus influenzae by N-methyl-N'-nitro-N-nitrosoguanidine and hydrazine, 2:42050
HAWAII/GEOTHERMAL EXPLORATION
Geothermal energy in the pacific region. Appendix A: exploration for a geothermal system in the Lualualei Valley, Oahu, Hawaii. Appendix B: exploration on Adak Island, Alaska, 2:41234 (AD-B-006305)
HAZARDOUS MATERIALS/ENVIRONMENTAL EFFECTS
The interrelationship of material toxicity, stream properties and quantity of spilled material in assessing the risk of hazardous material spills, 2:40991 (PB-259098)
HEAD/RADIOISOTOPE SCANNING
Estimation of lung and skeletal burdens of bone-seeking radionuclides in man from in vivo scintillation measurements of the thorax and the head, 2:42107 (BNWL-2088)
HEAT DISTRIBUTION SYSTEMS/DESIGN
Criteria for underground heat distribution systems, 2:41668 (N-76-28511)
HEAT DISTRIBUTION SYSTEMS/HEAT SOURCES
Waste heat utilisation by 'co-operative' group schemes, 2:41689
HEAT ENGINES
See also STIRLING ENGINES
HEAT ENGINES/DESIGN
Hydraulic heat engine (Patent), 2:41728
HEAT EXCHANGERS
See also HEAT PUMPS
HEAT EXCHANGERS/CORROSION PROTECTION
Corrosion in condensers and coolers of nuclear power due to cooling water, 2:41813 (EBO-P-673)
HEAT EXCHANGERS/COST
Coal technology program progress report for February 1977, 2:40732 (ORNL/TM-5858)
HEAT EXCHANGERS/DESIGN
Design of cryogenic heat exchangers for a superconducting magnet, 2:42296 (ORNL/MIT-242)
HEAT EXCHANGERS/FABRICATION
Fabricating closed channels by electroforming, 2:41919
HEAT EXCHANGERS/FAILURES
Operational experience with heat exchangers in nuclear power stations with light water reactors, 2:41480
HEAT EXCHANGERS/HEAT TRANSFER
Heat transfer in tube bundles of heat exchangers with flow baffles induced forced mixing (LMFBR), 2:41418
HEAT EXCHANGERS/OPTIMIZATION
Direct contact heat exhangers in geothermal power production, 2:41238
HEAT EXCHANGERS/TUBES
Mathematical model for cross-flow-induced vibrations of tube rows, 2:41920
HEAT PIPES/DESIGN
Heat pipe central solar receiver. Semiannual progress report, March 1, 1976-August 31, 1976, 2:41201 (COO/2839-1)
HEAT PUMPS/ECONOMICS
Evaluation of the air-to-air heat pump for residential space conditioning. Final report, 2:41673 (PB-255652)
HEAT PUMPS/TECHNOLOGY ASSESSMENT
Evaluation of the air-to-air heat pump for residential space conditioning. Final report, 2:41673 (PB-255652)
HEAT STORAGE
Underground storage of heat, 2:41566 (CEA-CONF-3638)
HEATING OILS/CHARGES
Selling prices and taxes on motor gasoline, diesel fuel, and heating oil in selected countries, as of October 1974. International economics report 1974, 2:40975 (PB-254943)
HEATING OILS/CHEMICAL COMPOSITION
Group composition of sulfur compounds in distillate fuels and method for determining this composition, 2:40967
HEATING OILS/COMBUSTION PRODUCTS
Investigation of size-dependent concentration of trace elements in aerosols emitted from the oil-fired heating plants, 2:40986 (N-76-27720)
HEATING OILS/TAXES
Selling prices and taxes on motor gasoline, diesel fuel, and heating oil in selected countries, as of October 1974. International economics report 1974, 2:40975 (PB-254943)
HEATING SYSTEMS/ECONOMICS
Residential space heating: a decision model of the dynamics of fuel penetration, 2:41676
HEATING SYSTEMS/MARKET
Residential space heating: a decision model of the dynamics of fuel penetration, 2:41676
HEAVY OILS/CHROMATOGRAPHY
Compound-type separation and characterization studies for a 370° to 535°C distillate of Swan Hills (South Field), Alberta, Canada, crude oil, 2:41022
HEAVY OILS/DESULFURIZATION
Thermal stability of sulfur compounds in heavy petroleum residual stocks, 2:40980
HEAVY OILS/HYDROCRACKING
Hydrocracking of residual oils and tars. I. The effect of feed dilution on the thermal hydrocracking of Athabasca bitumen, 2:41059
HEAVY OILS/MASS SPECTROSCOPY
Compound-type separation and characterization studies for a 370° to 535°C distillate of Swan Hills (South Field), Alberta, Canada, crude oil, 2:41022
HEAVY OILS/THERMODYNAMIC PROPERTIES
Thermal stability of sulfur compounds in heavy petroleum residual stocks, 2:40980
HELIUM/ATOM-MOLECULE COLLISIONS
Infrared spectroscopic measurements and analysis. Final report, Jan 1975-Mar 1976, 2:42194 (N-76-30320)
HELIUM/THERMAL CONDUCTIVITY
Shock tube study of the coefficient of thermal conductivity of helium, neon, argon and krypton, 2:42229 (INIS-mf-3404)
HEMATIN
See HEME
HEMATOPOIESIS
See BLOOD FORMATION
HEMATOPOIETIC SYSTEM/BIOLOGICAL RADIATION EFFECTS
Hematopoietic effects (Effects of internal ^{90}Sr and ^{226}Ra radiation, whole-body γ irradiation, and i.v.-administered fly ash silica particles), 2:42081 (UCD-472-123)
Study of haemopoietic microenvironment in vitro, 2:42070
HEMATOPORPHYRIN (HEME)
See HEME
HEME/REDUCTION
Pulse radiolytic investigation of single heme group reduction in human methemoglobin, 2:42072
HEMIN
See HEME
HEMOGLOBIN
See also METHEMOGLOBIN
HEMOGLOBIN/BINDING ENERGY
Use of a single venous blood sample to assess oxygen binding to haemoglobin, 2:42038
HEMOGLOBIN/BIOSYNTHESIS
Study of haemopoietic microenvironment in vitro, 2:42070
HEMOLYSIS
Slow phase hemolysis in hypotonic electrolyte solutions, 2:42028
HEMOPHILUS
See HAEMOPHILUS
HEMOPOIESIS
See BLOOD FORMATION
HEREDITY
See GENETICS
HETEROCYCLIC COMPOUNDS
See also PHTHALOCYANINES
PSORALEN
PYRIDINES
HETEROCYCLIC COMPOUNDS/REMOVAL
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
HIGH BTU GAS/CHEMICAL COMPOSITION
Economic comparison of producing SNG by Lawrence Livermore Laboratory's in situ coal gasification process with Lurgi aboveground coal gasification, 2:40758 (MERC/SP-76/3)
HIGH BTU GAS/MARKET
1976 ERDA in situ coal gasification program, 2:40746 (MERC/SP-76/3)
HIGH BTU GAS/PRODUCTION
Assessment of very high-temperature reactors in process applications. Appendix III. Engineering evaluation of process heat applications for very-high temperature reactors, 2:40788 (ORNL/TM-5411)
HIGH EXPLOSIVES
See CHEMICAL EXPLOSIVES
HIGH SPIN STATES/REVIEWS
Experimental status of high-spin states, 2:42197 (Juel-Conf-16(Vol.2))
HIGH-BETA PLASMA/PLASMA PRODUCTION
Waves and instabilities in steady-state high-beta plasmas. Final report 15 May 72-30 Jun 76, 2:42254 (AD-A-030924)
HIGH-BETA PLASMA/PLASMA WAVES
Waves and instabilities in steady-state high-beta plasmas. Final report 15 May 72-30 Jun 76, 2:42254 (AD-A-030924)
HIGH-FREQUENCY HEATING
See also ECR HEATING

Plasma anomalous heating by a strong electromagnetic field, 2:42219
HIGH-TEMPERATURE GAS-COOLED REACTOR
See HTGR TYPE REACTORS
HIGHWAYS
See ROADS
HIPPURAN/USES
Scintiphotos in the diagnosis of renal allograft malfunction, 2:42061
HOGER ONDERWIJS REACTOR
See HOR REACTOR
HOLMIUM PERCHLORATES/OSMOSIS
Isopiestic determination of the activity coefficients of some aqueous rare earth electrolyte solutions at 25°C. II. The rare earth perchlorates, 2:41874
HOR REACTOR/REACTOR SIMULATORS
Hybrid computer simulation of the dynamics of the Hoger Onderwijs Reactor, 2:41502 (IRI-131-76-01)
HORDEUM
See BARLEY
HOSPITALS/ENERGY CONSERVATION
Evaluation of energy conservation within health facilities. Final report, 2:41678 (PB-256006)
HOT PLASMA
See also LASER-PRODUCED PLASMA
HOT PLASMA/TRANSPORT THEORY
Transport processes and instabilities in magnetically confined plasmas with Tsub(itau) approximately Tsub(etau), 2:42234 (AED-Conf-76-506-023)
HOT WIRE ANEMOMETERS/PERFORMANCE TESTING
Eddy-flux measurements at the Dresden cooling pond (Fluxes of heat and momentum above Dresden reactors cooling pond), 2:42014 (ANL-75-60(Pt.4))
HOUSES/ENERGY CONSERVATION
Conservation of energy in the home. Highlight report, Volume XVII. Monthly report, 2:41623 (PB-254628)
HOUSES/SOLAR AIR CONDITIONING
An investigation of the acceptance of solar heating and cooling in the housing industry in New Mexico. Final technical report, 1 Aug 1975-31 Jul 1976, 2:41205 (N-76-28652)
Development of a solar-powered residential air conditioner: economic analysis (Rankine cycle power system), 2:41206 (N-76-30653)
Development of a solar-powered residential air conditioner. Program review, 2:41207 (N-76-30655)
Development of a solar-powered residential air conditioner (Rankine cycle power systems), 2:41208 (N-76-30656)
Development of a solar-powered residential air conditioner: screening analysis (RAnkine cycle power systems), 2:41209 (N-76-30659)
Development of a solar-powered residential air conditioner: system optimization preliminary specification (Rankine cycle power system), 2:41210 (N-76-30660)
HOUSES/SOLAR SPACE HEATING
An investigation of the acceptance of solar heating and cooling in the housing industry in New Mexico. Final technical report, 1 Aug 1975-31 Jul 1976, 2:41205 (N-76-28652)
Assessment of a single family residence solar heating system in a suburban development setting. Monthly report, 2:41212 (PB-254493)
Assessment of a single family residence solar heating system in a suburban development setting. Monthly report, 2:41213 (PB-254494)
Assessment of a single family residence solar heating system in a suburban development setting. Monthly report, 2:41214 (PB-254495)
Assessment of a single family residence solar heating system in a suburban development setting. Monthly report, 2:41215 (PB-254502)
Assessment of a single family residence solar heating system in a suburban development setting. Monthly report, 10 Aug-10 Sep 1975, 2:41216 (PB-255049)
Houses in Linkoping heated with solar energy, 2:41219
Inexpensive economical solar heating system for homes, 2:41204 (N-76-27671)
Low-energy house in Vetlanda (Passive heating system), 2:41222
Solar energy applications in agriculture: potential, research needs, and adoption strategies, summary and recommendations, 2:41217 (PB-255928)
Termoroc house in Limhamn, 2:41220
Zero-energy house in Lyngby, 2:41221
HOUSES/SPACE HEATING
Residential space heating: a decision model of the dynamics of fuel penetration, 2:41676
HTGR TYPE REACTORS
See also THTR-300 REACTOR
VRAIN REACTOR
HTGR TYPE REACTORS/COATED FUEL PARTICLES
Uranium loss from BISO-coated weak-acid-resin HTGR fuel, 2:41361 (ORNL/TM-5552)
HTGR TYPE REACTORS/FUEL CYCLE
Significant actinide and daughter activities from the HTGR fuel cycle, 2:41362 (PB-258150)
HTGR TYPE REACTORS/FUEL ELEMENTS
HTGR fuel and fuel cycle technology, 2:41359 (IAEA-CN-36/578)
HTGR fuels and core development program. Quarterly progress report for the period ending February 28, 1977 (Graphite and fuel irradiation; fission product release), 2:41355 (GA-A-14298)
HTGR TYPE REACTORS/PLANNING
Gas-cooled high temperature reactor: perspectives, problems and programmes, 2:41356 (IAEA-CN-36/94)
HTGR TYPE REACTORS/PRESSURE VESSELS
ISA: Ineractive Stress Analysis. A program for plane stress, plane strain and axisymmetric analysis of structural continua. User's manual, 2:41472 (ORNL/Sub/4164-2)
HTGR TYPE REACTORS/REACTOR KINETICS
Eigenvalue sensitivity study of a high temperature gas cooled reactor system, 2:41364
HTGR TYPE REACTORS/REACTOR MATERIALS
Advanced gas cooled nuclear reactor materials evaluation and development program. Progress report, September 23, 1976-December 31, 1976, 2:41350 (COO-2975-3)
HTGR fuels and core development program. Quarterly progress report for the period ending February 28, 1977 (Graphite and fuel irradiation; fission product release), 2:41355 (GA-A-14298)
HTGR TYPE REACTORS/REACTOR SAFETY
Safety analysis of the THTR-300 MW(e)-prototype-reactor and future HTR's under extreme accident conditions, 2:41528 (IAEA-CN-36/560)
HTGR TYPE REACTORS/SPENT FUEL ELEMENTS
Present status of fuel researches for VHTR in Japan, 2:41357 (IAEA-CN-36/168)
HTGR TYPE REACTORS/STEAM GENERATORS
Feedwater chemistry requirements for HTGR steam generator operation, 2:41365
HTGR TYPE REACTORS/SUPERHEATERS
Inelastic analysis of tubesheets by the finite element method, 2:41363
HTGR TYPE REACTORS/USES
Uses of nuclear energy in metallurgy - research and development, 2:41452 (TRINEC-P-926)
HUMAN CELLS
See ANIMAL CELLS
HUMAN POPULATIONS
See also RURAL POPULATIONS
HUMAN POPULATIONS/HEALTH HAZARDS
Biological effects of low levels of radiation exposure (Radiation hazards to man from radioactive consumer products), 2:42077 (UR-3490-1072)
Health and Safety Laboratory environmental quarterly, December 1, 1976-March 1, 1977, 2:42085 (HASL-318)
HUMIC ACIDS/ELECTRON SPIN RESONANCE
Investigation of the organomineral compounds of brown coals by the ESR method, 2:40830
HUMIC ACIDS/OXIDATION
Oxidative-reductive transformations of the quinoid groups of humic acids, 2:41875
HUNGARY/NUCLEAR POWER PLANTS
Development of the national nuclear programme and preparations for the introduction of nuclear power in Hungary, 2:41305 (IAEA-CN-36/420)
HVDC SYSTEMS/DESIGN
High voltage dc transmission applications offshore, 2:41297
HVDC SYSTEMS/TRANSFORMERS
Static convertor transformers for the hvdc transmission link Cabora Bassa-Apollo, 2:41298
HWGCR OF CZECHOSLOVAKIA
See BOHUNICE A-1 REACTOR
HYBRID ELECTRIC-POWERED VEHICLES/PERFORMANCE TESTING
DUO-bus, supplied either from overhead wire or from battery alternatively, 2:41733
HYBRID REACTORS/BREEDING RATIO
Fissile fuel breeding potential with paired fusion-fission reactors, 2:42289
HYBRID REACTORS/COMPARATIVE EVALUATIONS
Performance targets for fusion-fission (hybrid) reactors, 2:42272 (BNWL-2139)
HYBRID REACTORS/MULTIPLICATION FACTORS
Preliminary results of integral experiment on fusion-fission hybrid blanket assemblies, 2:42287 (JAERI-M-6495)
HYBRID REACTORS/NUCLEAR FUEL CONVERSION
Fissile fuel breeding potential with paired fusion-fission reactors, 2:42289

HYBRID SYSTEMS/DESIGN
Hybrid-engine (Patent), 2:41734
HYDRANE PROCESS
Extraction of useful chemical derivatives from coal (Book), 2:40811
HYDRANE PROCESS/ECONOMICS
Supplemental pipeline gas from coal by the Hydrane process, 2:40792
HYDRANE PROCESS/MATHEMATICAL MODELS
Supplemental pipeline gas from coal by the Hydrane process, 2:40792
HYDRAZINE/BIOLOGICAL EFFECTS
Reversions of two proline-requiring auxotrophs of Haemophilus influenzae by N-methyl-N'-nitro-N-nitrosoguanidine and hydrazine, 2:42050
HYDROCARBON FUEL CELLS/ELECTROLYTES
Research on electrochemical energy conversion systems. Final technical report, 1 Jul 1975-30 Jun 1976 (Trifluoromethanesulfonic acid electrolyte), 2:41663 (AD-A-034454)
HYDROCARBONS
See also ALKANES
ALKENES
ANTHRACENE
BIPHENYL
NAPHTHALENE
PYRENE
STYRENE
HYDROCARBONS/CHEMILUMINESCENCE
Cn production efficiencies from active nitrogen-hydrocarbon flames. Interim report, 2:41167 (AD-A-026638)
HYDROCARBONS/FLAMES
Cn production efficiencies from active nitrogen-hydrocarbon flames. Interim report, 2:41167 (AD-A-026638)
HYDROCARBONS/FRACTIONATION
Operation of primary fractionation tower in unit for pyrolysis of liquid hydrocarbons, 2:40943
HYDROCARBONS/PYROLYSIS
Operation of primary fractionation tower in unit for pyrolysis of liquid hydrocarbons, 2:40943
HYDROCARBONS/QUANTITATIVE CHEMICAL ANALYSIS
Chemistry of petroleum processing and extraction. I, 2:41011
HYDROCRACKING/CHEMICAL REACTION YIELD
Kinetic model for the prediction of hydrocracker yields, 2:40957
HYDROELECTRIC POWER PLANTS
See also PUMPED STORAGE POWER PLANTS
Existing and proposed fuel conversion facilities. Summary (Colorado, Montana, S. Dakota, N. Dakota, Utah, Wyoming), 2:41248 (PB-258264)
HYDROELECTRIC POWER PLANTS/OPTIMIZATION
About the proportioning of the water-flows for running water hydroelectric stations, 2:41178
HYDROELECTRIC POWER PLANTS/PUMPED STORAGE
Underground pumped storage research priorities. Technical planning study, 2:41558 (PB-254413)
HYDROELECTRIC POWER PLANTS/WATER HAMMER
Analysis of total pump-turbine system including pipelines, 2:41177
HYDROGEN/ADSORPTION
Equilibrium pressure and solubility of hydrogen in liquid lithium, 2:42323
HYDROGEN/ANAEROBIC DIGESTION
Investigation of converting the product of coal gasification to methane by the action of microorganisms: Phase I. Third quarterly report, May 1, 1976-August 1, 1976, 2:41169 (FE-2203-12)
HYDROGEN/CHEMICAL REACTION YIELD
Effects of heat and radiation on Gasbuggy chimney gas, 2:41039
HYDROGEN/CHEMICAL REACTIONS
Reactions of coal with nitrogen/hydrogen mixtures in a discharge, 2:40844
HYDROGEN/FLOW RATE
Prandtl-Meyer flow tables for parahydrogen at total temperatures from 30°K to 290°K and for nitrogen at total temperatures from 100°K to 300°K at total pressures from 1 atm to 10 atm, 2:41164 (N-76-30497)
HYDROGEN/MACH NUMBER
Prandtl-Meyer flow tables for parahydrogen at total temperatures from 30°K to 290°K and for nitrogen at total temperatures from 100°K to 300°K at total pressures from 1 atm to 10 atm, 2:41164 (N-76-30497)
HYDROGEN/METALLURGICAL EFFECTS
Indexing the degree of hydrogen embrittlement of 4340 steel using the barnacle electrode. Progress report, 2:41811 (AD-A-034661)
HYDROGEN/MOLECULE-MOLECULE COLLISIONS
Infrared spectroscopic measurements and analysis. Final report, Jan 1975-Mar 1976, 2:42194 (N-76-30320)
HYDROGEN/THERMODYNAMIC PROPERTIES
Experimental apparatus to study forced convection heat transfer to supercritical cryogenic hydrogen, 2:41165 (N-76-30504)
HYDROGEN/TRANSPORT
Production and transport of hydrogen slush. Final report, 2:41163 (N-76-24421)
HYDROGEN 3
See TRITIUM
HYDROGEN FUELS
Production and utilization of alternative secondary energy carriers, 2:41158 (N-76-24726)
HYDROGEN FUELS/FEASIBILITY STUDIES
Potential of liquid hydrogen as a military aircraft fuel, 2:41753 (AD-A-026666)
HYDROGEN METERS
Sodium contamination measurement with plugging meter and hydrogen leak detection system, 2:41414
HYDROGEN PRODUCTION
Hydrogen as energy carrier. Future possibilities in the Netherlands, 2:41159 (N-76-24723)
Production and transport of hydrogen slush. Final report, 2:41163 (N-76-24421)
HYDROGEN PRODUCTION/COST
Assessment of very high-temperature reactors in process applications. Appendix III. Engineering evaluation of process heat applications for very-high temperature reactors, 2:40788 (ORNL/TM-5411)
HYDROGEN PRODUCTION/ELECTROLYSIS
Will the large-scale production of hydrogen be part of the energy problem or part of its solution, 2:41161
HYDROGEN PRODUCTION/ENERGY CONSUMPTION
Will the large-scale production of hydrogen be part of the energy problem or part of its solution, 2:41161
HYDROGEN PRODUCTION/PHOTOLYSIS
Photoelectrolytic production of hydrogen using semiconductor electrodes. Interim report, 2:41160 (N-76-24374)
HYDROGEN PRODUCTION/SYSTEMS ANALYSIS
Will the large-scale production of hydrogen be part of the energy problem or part of its solution, 2:41161
HYDROGEN PRODUCTION/THERMOCHEMICAL PROCESSES
Production of refined intermediate fuels with high temperature reactors, 2:41450 (IAEA-CN-36/376)
Will the large-scale production of hydrogen be part of the energy problem or part of its solution, 2:41161
HYDROGEN STORAGE
See also HYDROGEN-BASED ECONOMY
TANKS
HYDROGEN STORAGE/LANTHANUM HYDRIDES
Investigation of metal hydride materials as hydrogen reservoirs for metal-hydrogen batteries, 2:41162 (N-76-27667)
HYDROGEN STORAGE/NICKEL HYDRIDES
Investigation of metal hydride materials as hydrogen reservoirs for metal-hydrogen batteries, 2:41162 (N-76-27667)
HYDROGEN SULFIDES/ABSORPTION SPECTROSCOPY
Nature and distribution of sulphur compounds in Darius crude, 2:41017
HYDROGEN SULFIDES/POTENTIOMETRY
Nature and distribution of sulphur compounds in Darius crude, 2:41017
HYDROGEN SULFIDES/QUANTITATIVE CHEMICAL ANALYSIS
Effect of hydrogen sulfide on fish and invertebrates. Part II. Hydrogen sulfide determination and relationship between pH and sulfide toxicity. Final report Aug 72-Mar 75, 2:42123 (PB-257246)
HYDROGEN SULFIDES/REMOVAL
Supplemental pipeline gas from coal by the Hydrane process, 2:40792
Utilization of low BTU gas from in-situ coal gasification for on-site power generation, 2:40773 (MERC/SP-76/3)
HYDROGEN SULFIDES/TOXICITY
Effect of hydrogen sulfide on fish and invertebrates. Part II. Hydrogen sulfide determination and relationship between pH and sulfide toxicity. Final report Aug 72-Mar 75, 2:42123 (PB-257246)
HYDROGEN-BASED ECONOMY
Hydrogen as energy carrier. Future possibilities in the Netherlands, 2:41159 (N-76-24723)
Will the large-scale production of hydrogen be part of the energy problem or part of its solution, 2:41161
HYDROLOGY/BIBLIOGRAPHIES
Time series forecasting and prediction (a bibliography with abstracts). Report for 1964-Jan 1977, 2:41666 (NTIS/PS-77/0042)
HYDROTHERMAL SYSTEMS/GEOCHEMISTRY
Geology and geochemistry of the Dunes Hydrothermal System, Imperial Valley of California, 2:41241 (PB-258098)
HYDROTHERMAL SYSTEMS/GEOLOGY
Geology and geochemistry of the Dunes Hydrothermal System, Imperial Valley of California, 2:41241 (PB-258098)

I

ICE/TOPOLOGICAL MAPPING
SEASAT economic assessment. Volume 6: Arctic operations case study and generalization. Final report, Feb 1974-Aug 1975, 2:40995 (N-76-28619)
IDAHO/WATER QUALITY
Environmental quality profile, 1976. Alaska, Oregon, Idaho, Washington. Final report, 2:41990 (PB-255101)
ILLINOIS/AIR POLLUTION
Measurements of atmospheric turbidity in an arc downwind of St. Louis, 2:41955 (ANL-75-60(Pt.4))
PBL structure: the Sangamon Experiment of 1975 (Physical mechanisms for regional air pollution in Illinois), 2:41951 (ANL-75-60(Pt.4))
ILLINOIS/COAL MINING
Strip mining in the corn belt: the destruction of high capability agricultural land for strip-minable coal in Illinois, 2:41642
ILLINOIS/GEOLOGIC STRUCTURES
Application of EREP imagery to fracture-related mine safety hazards in coal mining and mining-environmental problems in Indiana. Final report Apr 73-Apr 75, 2:40869 (E-76-10419)
ILLINOIS/LAND USE
Strip mining in the corn belt: the destruction of high capability agricultural land for strip-minable coal in Illinois, 2:41642
ILLINOIS/METEOROLOGY
Measurements of atmospheric turbidity in an arc downwind of St. Louis, 2:41955 (ANL-75-60(Pt.4))
PBL structure: the Sangamon Experiment of 1975 (Physical mechanisms for regional air pollution in Illinois), 2:41951 (ANL-75-60(Pt.4))
IMIDES/MECHANICAL PROPERTIES
Advanced composites: mechanical properties and hardware programs for selected resin matrix materials (Boron and graphite fiber reinforcement), 2:41860 (N-76-24364)
IMMUNE REACTIONS
Sufficient absorption: a quantitative method to replace exhaustive absorption, 2:42051
IMMUNE REACTIONS/AGE DEPENDENCE
Immune competence of ^{226}Ra-injected dogs and age-matched controls as measured by the micro-lymphocyte stimulation test, 2:42087 (UCD-472-123)
IMMUNE REACTIONS/BIOLOGICAL RADIATION EFFECTS
Control of IgE and IgGl antibody production in mice (X Radiation), 2:42082
Immune competence of ^{226}Ra-injected dogs and age-matched controls as measured by the micro-lymphocyte stimulation test, 2:42087 (UCD-472-123)
IMMUNE REACTIONS/CONTROL
Selective suppression of immune responses. Regulation of antibody formation and cell-mediated immunity by antibody (Review), 2:42052
IMMUNE REACTIONS/TESTING
Leukocyte migration inhibition assay (Cell mediated immunity in dogs), 2:42065 (UCD-472-123)
IMMUNE SERA
See IMMUNE SERUMS
IMMUNE SERUMS/IMMUNE REACTIONS
Sufficient absorption: a quantitative method to replace exhaustive absorption, 2:42051
IMMUNITY/GENETIC CONTROL
Studies in developmental immunogenetics. Annual progress report, 2:42062 (CALT-767P6-X11)
IMMUNOGLOBULINS/CONTROL
Control of IgE and IgGl antibody production in mice (X Radiation), 2:42082
INCONEL 600/CORROSION
Importance of phosphate in the system iron/water. II. The chemistry of the system, 2:41817
INCONEL 600/STRESS CORROSION
Caustic stress corrosion cracking (LMFBR), 2:41388 (HEDL-SA-1122)
INCONEL 718/STRESS CORROSION
Caustic stress corrosion cracking (LMFBR), 2:41388 (HEDL-SA-1122)
INCONEL ALLOYS
See also INCONEL 600
INCONEL 718
INCONEL ALLOYS/COATINGS
Electrodeposition of titanium diboride coatings. Report of investigations 1976, 2:41816 (PB-257 384)
IN-CORE FUEL MANAGEMENT
See FUEL MANAGEMENT
INDIA/COAL RESERVES
Coal resources for the fertilizer plant at Korba, Madhya Pradesh, 2:40868
INDIA/FUEL FABRICATION PLANTS
Integrated planning for a fuel industry with emphasis on minimum size to fabricate own fuel, 2:41086 (IAEA-CN-36/386)
INDIA/NUCLEAR INDUSTRY
Experience in the manufacture of nuclear equipment in India, 2:41307 (IAEA-CN-36/462)
INDIA/NUCLEAR POWER
India's nuclear power programme and constraints encountered in its implementation, 2:41369 (IAEA-CN-36/385)
INDIA/RADIOACTIVE WASTE MANAGEMENT
Management of radioactive wastes: an overview of the Indian programme, 2:41123 (IAEA-CN-36/388)
INDIANA/GEOLOGIC STRUCTURES
Application of EREP imagery to fracture-related mine safety hazards in coal mining and mining-environmental problems in Indiana. Final report Apr 73-Apr 75, 2:40869 (E-76-10419)
INDUSTRIAL PLANTS
See also FEED MATERIALS PLANTS
WASTE PROCESSING PLANTS
INDUSTRIAL PLANTS/AIR POLLUTION
Source assessment: glass container manufacturing plants. Final report, Sep 1975-Sep 1976, 2:41977 (PB-262002)
INDUSTRIAL PLANTS/POWER DEMAND
Changes in an electric utility's fuel base, 2:41653
INDUSTRY
See also CHEMICAL INDUSTRY
DEVELOPING COUNTRIES
METAL INDUSTRY
NATURAL GAS INDUSTRY
NUCLEAR INDUSTRY
PETROLEUM INDUSTRY
INDUSTRY/AIR POLLUTION CONTROL
Prevention of dust pollution from boilers, 2:41281
INDUSTRY/ENERGY DEMAND
Development of methods for forecasting the national industrial demand for energy. Final report, 2:41629 (PB-257914)
INDUSTRY/HEAT RECOVERY
Waste heat utilisation by 'co-operative' group schemes, 2:41689
INDUSTRY/THERMAL POWER PLANTS
Study of inplant electric power generation in the chemical, petroleum refining, and paper and pulp industries. Final report, 2:41247 (PB-255659)
INFLAMMATION/RADIOINDUCTION
Pathology in a lifespan study of x-irradiated adult female beagles, 2:42079 (UCD-472-123)
INFORMATION CENTERS
Atomic data for controlled fusion research, 2:42231 (ORNL-5206(Vol.1))
INFORMATION RETRIEVAL/COMPUTER CODES
Operation and maintenance of the Rare-Earth Information Center's Information Retrieval System (RICIRS) version 2 (In PL/I for IBM 360 or 370 OSMVT), 2:42337 (IS-4104)
INFORMATION RETRIEVAL/ON-LINE SYSTEMS
Investigation into the computerized data bases of the Employment and Training Administration. Regional Management Information System Project (RMIS) report on second-year activities, 1975-1976, 2:42338 (LBL-6122)
INFORMATION SYSTEMS/PROGRAMMING
Set Theoretic Data Structures (STDS): a tutorial, 2:42339 (UCID-17378)
INFRARED SURVEYS/DATA PROCESSING
U.s. geological survey's Project BIRDDOG (basic investigation of remotely detectable deposits of oil and gas), 2:40918
INHIBITORS (CORROSION)
See CORROSION INHIBITORS
IN-SERVICE INSPECTION/RELIABILITY
Reproducibility problems of in-service ultrasonic testing results, 2:41470 (INIS-mf-3389)
IN-SITU COMBUSTION/HEAT LOSSES
In situ combustion of coal for energy: a progress report, 2:40908 (MERC/SP-76/3)
IN-SITU COMBUSTION/SIMULATION
Two-dimensional studies of coal pyrolysis: preliminary results, 2:40799 (MERC/SP-76/3)
IN-SITU GASIFICATION
Ignition of coalbeds for underground gasification (Longwall underground generator), 2:40781 (MERC/SP-76/3)
Pyrolysis of large coal blocks: implications of heat and mass transport effects for in situ gasification (3 refs; comparison of block and powder pyrolysis), 2:40798 (CONF-770301-13)
Texas utilities program status report (Company bought Russian know-how and made several trips to Russia for observation), 2:40751 (MERC/SP-76/3)
Utilization of low BTU gas from in-situ coal gasification for on-site power generation, 2:40773 (MERC/SP-76/3)
IN-SITU GASIFICATION/BOREHOLE LINKING
Fundamental aspects of in situ electrocarbonization and electrogasification of coal, 2:40787 (MERC/SP-76/3)

Hydraulic fracturing thin coal seams in preparation for in situ gasification, 2:40814 (MERC/SP-76/3)
Rock mechanics aspects of in-situ gasification with special reference to Texas lignite, 2:40768 (MERC/SP-76/3)
Status of the Linked Vertical Well process in underground coal gasification (Hanna II Experiment), 2:40772 (MERC/SP-76/3)

IN-SITU GASIFICATION/CHEMICAL REACTIONS
Chemical reactor modeling of in situ coal gasification, 2:40764 (MERC/SP-76/3)

IN-SITU GASIFICATION/COAL PREPARATION
Ammonia injection scheme for fracturing and permeability enhancement of coal beds (Chemical comminution), 2:40780 (MERC/SP-76/3)

IN-SITU GASIFICATION/COMPARATIVE EVALUATIONS
Factors influencing the economics of large-scale in situ coal gasification operations, 2:40754 (MERC/SP-76/3)

IN-SITU GASIFICATION/DATA ACQUISITION SYSTEMS
Practical considerations in designing an UCG field test (Hanna Experiment), 2:40770 (MERC/SP-76/3)
Real time process monitoring in underground coal gasification, 2:40760 (MERC/SP-76/3)

IN-SITU GASIFICATION/ECONOMICS
Economic comparison of producing SNG by Lawrence Livermore Laboratory's in situ coal gasification process with Lurgi aboveground coal gasification, 2:40758 (MERC/SP-76/3)
Economic evaluation of underground coal gasification, 2:40755 (MERC/SP-76/3)
Economics of underground coal gasification, 2:40756 (MERC/SP-76/3)
Economics of manufacturing synthesis gas produced by underground coal gasification, 2:40757 (MERC/SP-76/3)
Factors influencing the economics of large-scale in situ coal gasification operations, 2:40754 (MERC/SP-76/3)

IN-SITU GASIFICATION/ENERGY MODELS
Use of an interactive energy model for technology assessment with special reference to underground coal gasification, 2:40790 (PB-255543)

IN-SITU GASIFICATION/ENVIRONMENTAL EFFECTS
Groundwater contamination from in-situ coal gasification: laboratory studies, 2:40854 (MERC/SP-76/3)

IN-SITU GASIFICATION/ENVIRONMENTAL IMPACTS
Hydrogeologic assessment of an underground coal gasification project site Grant District, Wettzel County, W. Va., 2:40855 (MERC/SP-76/3)
Preliminary laboratory and modeling studies on the environmental impact of 'in-situ' coal gasification, 2:40753 (MERC/SP-76/3)

IN-SITU GASIFICATION/EXPLOSIVE FRACTURING
Calculation of fracture and permeability enhancement from underground explosions in coal, 2:40767 (MERC/SP-76/3)
Economic comparison of producing SNG by Lawrence Livermore Laboratory's in situ coal gasification process with Lurgi aboveground coal gasification, 2:40758 (MERC/SP-76/3)
LLL in-situ coal gasification program, 2:40749 (MERC/SP-76/3)

IN-SITU GASIFICATION/FEASIBILITY STUDIES
Coal I: current advances in coal chemistry and mining techniques (Book), 2:40834
Feasibility of in-situ coal gasification in the Warrior coalfield; a progress report, 2:40747 (MERC/SP-76/3)
In-situ gasification in Australia: prospects, potential, and research activities (Cyclic operation), 2:40774 (MERC/SP-76/3)
New concept for in situ coal gasification, 2:40791
Research on in situ gasification of Texas lignite at the University of Texas, 2:40752 (MERC/SP-76/3)
Underground gasification at the University of Kentucky, 2:40778 (MERC/SP-76/3)

IN-SITU GASIFICATION/GROUND SUBSIDENCE
Status of the Linked Vertical Well process in underground coal gasification (Hanna II Experiment), 2:40772 (MERC/SP-76/3)

IN-SITU GASIFICATION/MATHEMATICAL MODELS
Chemical reactor modeling of in situ coal gasification, 2:40764 (MERC/SP-76/3)
Numerical modeling of the stream method of underground coal gasification, 2:40763 (MERC/SP-76/3)
Prospects and problems for UCG in Britain, 2:40775 (MERC/SP-76/3)
Review of current UCG model capabilities, 2:40782 (MERC/SP-76/3)
Theoretical analysis of Soviet in situ coal gasification field tests, 2:40766 (MERC/SP-76/3)
Thermo-viscoelastic considerations associated with underground coal gasification, 2:40765 (MERC/SP-76/3)

IN-SITU GASIFICATION/MEETINGS
Proceedings of second annual underground coal gasification symposium, 2:40745 (MERC/SP-76/3)

IN-SITU GASIFICATION/MONITORING
Electromagnetic wave propagation within a subsurface coal seam for in-situ gasification application, 2:40761 (MERC/SP-76/3)
Monitoring of emissions from an in situ coal gasification experiment (Hanna Experiment), 2:40762 (MERC/SP-76/3)

IN-SITU GASIFICATION/PLANNING
Hydraulic fracturing thin coal seams in preparation for in situ gasification, 2:40814 (MERC/SP-76/3)
Status of the MERC in situ gasification of Eastern U.S. coals project, 2:40750 (MERC/SP-76/3)

IN-SITU GASIFICATION/REMOTE SENSING
Post burn analysis techniques applicable to underground coal gasification (Hanna I Experiment), 2:40771 (MERC/SP-76/3)
Remote monitoring of an in situ coal gasification process (Hanna II experiment), 2:40759 (MERC/SP-76/3)
Results and status of the second Hanna in situ coal gasification experiment, 2:40748 (MERC/SP-76/3)

IN-SITU GASIFICATION/RESEARCH PROGRAMS
1976 ERDA in situ coal gasification program, 2:40746 (MERC/SP-76/3)
Research on in situ gasification of Texas lignite at the University of Texas, 2:40752 (MERC/SP-76/3)
Results and status of the second Hanna in situ coal gasification experiment, 2:40748 (MERC/SP-76/3)

IN-SITU GASIFICATION/ROCK MECHANICS
Rock mechanics aspects of in-situ gasification with special reference to Texas lignite, 2:40768 (MERC/SP-76/3)

IN-SITU GASIFICATION/SIMULATION
In Situ Hydrocarbon Recovery Simulation Laboratory research at Morgantown Energy Research Center, 2:40779 (MERC/SP-76/3)
Lawrence Livermore Laboratory coal gasification program: underground reaction modeling and laboratory combustion-tube experiments, 2:40777 (MERC/SP-76/3)
Mechanical properties of coal for simulation of underground gasification processes, 2:40815 (MERC/SP-76/3)
Reaction kinetics of coal char gasification under conditions expected in underground coal gasification, 2:40776 (MERC/SP-76/3)
Real mass and energy transport coefficients determined from UCG process simulation experiments, 2:40786 (MERC/SP-76/3)

IN-SITU GASIFICATION/SITE SELECTION
Practical considerations in designing an UCG field test (Hanna Experiment), 2:40770 (MERC/SP-76/3)

IN-SITU GASIFICATION/TEMPERATURE DISTRIBUTION
Some observations from temperature measurements on recent underground coal gasification experiments (Hanna II experiment), 2:40769 (MERC/SP-76/3)

IN-SITU GASIFICATION/TEMPERATURE MEASUREMENT
Some observations from temperature measurements on recent underground coal gasification experiments (Hanna II experiment), 2:40769 (MERC/SP-76/3)

IN-SITU GASIFICATION/WELL DRILLING
Algorithm for cost effectiveness of directional versus vertical well drilling, 2:40785 (MERC/SP-76/3)

INSOLATION/DATA
Solar microclimatology. Final report (Data for Arizona), 2:41233 (N-76-28738)

INSTITUTE FOR REACTOR SAFETY/RECOMMENDATIONS
Recommendations of the Reactor Safety Commission, 1971-1974 (German Federal Republic), 2:41434 (PB-254804-T/SL)

INTERFEROMETERS/PERFORMANCE
CO_2-laser interferometer with direct read-out of phase-shift, 2:42227 (Rijnhuizen-76-100)
Novel interferometer for the measurement of plasma density, 2:42226 (LA-6727-MS)

INTERMEDIATE BTU GAS/MARKET
1976 ERDA in situ coal gasification program, 2:40746 (MERC/SP-76/3)

INTERMETALLIC COMPOUNDS/MAGNETIZATION
Magnetic ordering in the actinide intermetallics, 2:41804

INTERNAL COMBUSTION ENGINES
See also DIESEL ENGINES
ROTARY ENGINES
STRATIFIED CHARGE ENGINES

INTERNAL COMBUSTION ENGINES/AUTOMOTIVE FUELS
Method for production of a gas mixture using a catalytically converted fuel and a gas serving as oxygen carrier (Patent), 2:41754

INTERNAL COMBUSTION ENGINES/DESIGN
Hybrid-engine (Patent), 2:41734
Lifting cylinder combustion engine with preheated suction pipe (Patent), 2:41714

INTERNAL COMBUSTION ENGINES/EXHAUST SYSTEMS
Sound transmission in the 180° duct bends of rectangular section, 2:41747

INTERNAL COMBUSTION ENGINES/RADIANT HEAT TRANSFER
Evaluation of radiant heat exchange in the cylinders of internal combustion engines, 2:41713

INTERNAL COMBUSTION ENGINES/SUPERCHARGERS
Classification and systematization of possible combined engine schemes, 2:41746

INTERNAL COMBUSTION ENGINES/TECHNOLOGY ASSESSMENT
Prospects of development of internal combustion engines, 2:41712
INTERNAL CONTAMINATION
See RADIONUCLIDE KINETICS
INTERNAL ELECTROMAGNETIC PULSES/MATHEMATICAL MODELS
Internal interaction analysis: topological concepts and needed model improvements. Final report, 2:41932 (AD-A-027047)
INTERNATIONAL ENERGY AGENCY/RESEARCH PROGRAMS
International Energy Agency: coal research, 2:40730
INTERPLANETARY MAGNETIC FIELDS/BOUNDARY LAYERS
Interplanetary boundary layers at 1 AU, 2:42174 (N-76-31115)
INTERPLANETARY MAGNETIC FIELDS/TABLES
Solar-geophysical data number 387. Part I. Prompt reports. Data for October 1976-September 1976. Explanation of data reports issued as number 378 (supplement) February 1976, 2:42171 (PB-263008)
IODINE/BIOLOGICAL EFFECTS
Iodine to control microbiological growth in fuel storage basin water, 2:41109 (ICP-1109)
IODINE/EXPLORATION
Iodine in oil and gas fields: especially on the geochemical consideration of the prospecting for iodine deposits, 2:42145 (N-76-27750)
IODINE/GEOCHEMISTRY
Iodine in oil and gas fields: especially on the geochemical consideration of the prospecting for iodine deposits, 2:42145 (N-76-27750)
IODINE 129/FISSION PRODUCT RELEASE
^{129}I as an example: problems of reprocessing, 2:41101
IODINE 129/MAXIMUM PERMISSIBLE INTAKE
Dose limitations to humans from ^{129}I, 2:42086 (UCD-472-123)
IODINE 129/METABOLISM
Metabolism of ^{129}I in young beagles, 2:42092 (UCD-472-123)
IODINE 129/RADIATION DOSE DISTRIBUTIONS
Dose limitations to humans from ^{129}I, 2:42086 (UCD-472-123)
IODINE 131/METABOLISM
^{131}I metabolism in pregnant and fetal guinea pigs, 2:42091 (UCD-472-123)
ION ACOUSTIC WAVES/EXCITATION
Model of excitation of an acoustic wave by the 'double plasma' mechanism, 2:42266
ION ACOUSTIC WAVES/WAVE PROPAGATION
Propagation of ion acoustic solitons in a warm ion plasma, 2:42264
Propagation of ion acoustic solitons in a two component plasma, 2:42265
ION-ATOM COLLISIONS/DATA COMPILATION
Atomic data for controlled fusion research, 2:42231 (ORNL-5206(Vol.1))
IONIZING RADIATIONS/BIOLOGICAL RADIATION EFFECTS
Quadrennial report of the division of biological effects, 1971-1974, 2:42078 (PB-258436)
ION-MOLECULE COLLISIONS/DATA COMPILATION
Atomic data for controlled fusion research, 2:42231 (ORNL-5206(Vol.1))
IONOSPHERE
See also D REGION
E REGION
F REGION
IONOSPHERE/CHEMICAL REACTIONS
Response of the ionosphere to the injection of chemically reactive vapors, 2:42183 (N-76-28719)
IONOSPHERE/ELECTRON DENSITY
Report on the geophysical description and available data associated with rocket PF-SH-92 (IC 519.07-1B), 2:42178 (AD-A-034381)
Response of the ionosphere to the injection of chemically reactive vapors, 2:42183 (N-76-28719)
Study and analysis of total electron content and scintillation data. Report for 1 Jul 1975-30 Jun 1976, 2:42179 (AD-A-034490)
IONOSPHERE/PLASMA DRIFT
Ionospheric plasma cloud dynamics. Final report, 2:42182 (N-76-28715)
IONOSPHERE/PLASMA WAVES
Waves and instabilities in steady-state high-beta plasmas. Final report 15 May 72-30 Jun 76, 2:42254 (AD-A-030924)
IONOSPHERE/PROTON DENSITY
The correlation of the 10 to 30 MeV proton flux from the NOAA satellites and the Thule 30 MHz riometer. Technical memo, 2:42186 (PB-256 102)
IONOSPHERE/WAVE PROPAGATION
ATS-6 40- and 360-MHz differential phase measurements. Environmental research papers, 2:42176 (AD-A-030739)
IRIDIUM ALLOYS/CRYSTAL STRUCTURE
Crystal structure of the compounds Pu_5X_4 (X=Rh, Ir), 2:41766
IRIDIUM ALLOYS/DE HAAS-VAN ALPHEN EFFECT
de Haas-van Alphen effect in URh_3 and UIr_3, 2:41762
IRIDIUM ALLOYS/ELECTRONIC STRUCTURE
Electronic energy band structure of actinide metals and intermetallics, 2:41772
IRON/ABSORPTION SPECTROSCOPY
Evaluation of a carbon-rod atomizer for routine determination of trace metals by atomic-absorption spectroscopy. Applications to analysis of lubricating oil and crude oil, 2:41016
IRON/CATALYTIC EFFECTS
Mass-spectrometric measurements of enhanced methanation activity over cobalt and nickel foils. Interim report, 2:41170 (AD-A-034675)
IRON/CORROSION
Importance of phosphate in the system iron/water. II. The chemistry of the system, 2:41817
IRON/MINERAL CYCLING
Exchange of manganese, iron, copper, and zinc between dissolved and particulate forms in the Newport River estuary, North Carolina, 2:42003 (RLO-2227-T12-71)
IRON/NEUTRON REACTIONS
Calculations of the neutron emission spectra from materials bombarded with 14-mev neutrons, 2:42290
IRON 57/MOESSBAUER EFFECT
Itinerant magnetism in $NpFe_2Si_2$ and $NpCo_2Si_2$, 2:41799
IRON ALLOYS
See also INCONEL 600
IRON BASE ALLOYS
STEELS
IRON ALLOYS/FRACTURE PROPERTIES
Nonlinear compliance curves caused by crack closure in fracture tests of tungsten alloy, 2:41786
IRON ALLOYS/MAGNETIZATION
Itinerant magnetism in $NpFe_2Si_2$ and $NpCo_2Si_2$, 2:41799
IRON ALLOYS/REDUCTION
Estimation of the reducing properties of ferrocoke as a carbonaceous reducing agent in the smelting of ferroalloys, 2:40828
IRON ALLOYS/SMELTING
Estimation of the reducing properties of ferrocoke as a carbonaceous reducing agent in the smelting of ferroalloys, 2:40828
IRON BASE ALLOYS/CORROSION
The role of passive film growth kinetics and properties in stress corrosion and crevice corrosion susceptibility. Technical summary report No. 7, Oct 1975-Nov 1976, 2:41812 (AD-A-034723)
IRON BASE ALLOYS/THERMODYNAMIC PROPERTIES
Thermodynamic properties of the binary Laves phase compounds of plutonium with the group VIIIa metals, 2:41797
IRON COMPOUNDS/CHEMICAL PROPERTIES
Estimation of the reducing properties of ferrocoke as a carbonaceous reducing agent in the smelting of ferroalloys, 2:40828
IRRIGATION/DEMONSTRATION PROGRAMS
Solar powered irrigation system. Quarterly progress report to ERDA/DSE, 2:41224 (SAND-76-0358)
IRRIGATION/ECONOMICS
Effect of changing input and product prices on the demand for irrigation water in Texas. Technical report, 2:41586 (PB-255731)
IRRIGATION/SOLAR WATER PUMPS
Solar powered irrigation system. Quarterly progress report to ERDA/DSE, 2:41224 (SAND-76-0358)
ISABELLE STORAGE RINGS/BEAM DYNAMICS
Possible effects of lowering the periodicity in ISABELLE, 2:41925 (BNL-22237)
ISCHEMIA/DIAGNOSIS
Quantitation of ischemic and infarcted myocardium: relation between 99 Tc pyrophosphate and regional and total coronary blood flow, myocardial function and metabolism. Annual scientific report, 1 Jul 1975-31 Mar 1976, 2:42060 (PB-262160)
ISRAEL/ENERGY DEMAND
Guidelines for forecasting energy demand, 2:41627 (IA-1327)
ISRAEL/ENERGY SUPPLIES
Guidelines for forecasting energy demand, 2:41627 (IA-1327)
ITALY/NUCLEAR POWER
Contribution of nuclear energy to the meeting of Italy's electric power requirements, 2:41308 (IAEA-CN-36/464)
Italian nuclear activities in 1974, 2:41311

J

JAPAN/NUCLEAR POWER
Plutonium utilization in thermal and fast reactor in Japan, 2:41303 (IAEA-CN-36/162)

JAPAN/PLUTONIUM RECYCLE
Plutonium utilization in thermal and fast reactor in Japan, 2:41303 (IAEA-CN-36/162)
JAPAN/RADIOACTIVE WASTE MANAGEMENT
Development of radioactive waste management at Japan Atomic Energy Research Institute, 2:41115 (IAEA-CN-36/156)
JAPAN INST PLASMA PHYS STELLAR
See JIPP STELLARATOR
JEMEZ MOUNTAINS/ELECTRICAL SURVEYS
Deep electrical resistivity investigations coupled with dry geothermal reservoir experiments in New Mexico. Technical progress report, 2:41235 (PB-258100)
JEMEZ MOUNTAINS/GEOTHERMAL EXPLORATION
Deep electrical resistivity investigations coupled with dry geothermal reservoir experiments in New Mexico. Technical progress report, 2:41235 (PB-258100)
JEMEZ MOUNTAINS/HOT-DRY-ROCK SYSTEMS
Deep electrical resistivity investigations coupled with dry geothermal reservoir experiments in New Mexico. Technical progress report, 2:41235 (PB-258100)
JET ENGINE FUELS
Potential of liquid hydrogen as a military aircraft fuel, 2:41753 (AD-A-026666)
JET ENGINE FUELS/CHEMICAL COMPOSITION
Influence of dissolved water on static electrification of jet fuels, 2:40962
JET ENGINE FUELS/ELECTROSTATICS
Influence of dissolved water on static electrification of jet fuels, 2:40962
JET ENGINE FUELS/MARKET
Weekly petroleum statistics reports, 1974-1975, 2:40978 (PB-255920)
JET ENGINE FUELS/MOISTURE
Influence of dissolved water on static electrification of jet fuels, 2:40962
JET ENGINE FUELS/PHYSICAL PROPERTIES
Service properties of jet fuels in relation to group composition of sulfur compounds in fuel (Thermal stability metal corrosion, lubricity, and electrical charging tendency), 2:40963
JIPP STELLARATOR/CONTROL SYSTEMS
Experiments on JIPP T-II, a hybrid system of stellarator and Tokamak, 2:42271 (AED-Conf-76-506-007)
JIPP STELLARATOR/SPECIFICATIONS
Experiments on JIPP T-II, a hybrid system of stellarator and Tokamak, 2:42271 (AED-Conf-76-506-007)
JUPITER PLANET/PLANETARY MAGNETOSPHERES
Polar aurora in the magnetosphere, 2:42193 (N-76-27751)

K

KALKAR POWER REACTOR
See SNR-1 REACTOR
KANUPP REACTOR/CONSTRUCTION
Experience from construction and operation of Karachi nuclear power plant, 2:41371 (IAEA-CN-36/547)
KARACHI NUCLEAR POWER PLANT
See KANUPP REACTOR
KERNKRAFTWERK OBRIGHEIM
See OBRIGHEIM REACTOR
KERNKRAFTWERK PHILIPPSBURG-1
See PHILIPPSBURG-1 REACTOR
KERNKRAFTWERK STADE
See STADE REACTOR
KEROSENE/MARKET
Weekly petroleum statistics reports, 1974-1975, 2:40978 (PB-255920)
KIDNEYS/NECROSIS
Aminoaciduria and proteinuria in rats after a single intraperitoneal injection of Ni(II), 2:42126
KIDNEYS/SCINTISCANNING
Scintiphotos in the diagnosis of renal allograft malfunction, 2:42061
KKP-1 PHILIPPSBURG REACTOR
See PHILIPPSBURG-1 REACTOR
KKS REACTOR
See STADE REACTOR
KOZLODUY-1 REACTOR/CONSTRUCTION
Experience of NPS construction in the People's Republic of Bulgaria, 2:41332 (IAEA-CN-36/537)
KOZLODUY-2 REACTOR/CONSTRUCTION
Experience of NPS construction in the People's Republic of Bulgaria, 2:41332 (IAEA-CN-36/537)
KRYPTON/THERMAL CONDUCTIVITY
Shock tube study of the coefficient of thermal conductivity of helium, neon, argon and krypton, 2:42229 (INIS-mf-3404)
KS-150 REACTOR
See BOHUNICE A-1 REACTOR
KWO REACTOR
See OBRIGHEIM REACTOR

L

LABORATORY ANIMALS/BIOLOGICAL EFFECTS
Selection of animal models for evaluation of inhalation hazards in man, 2:42129
LABORATORY ANIMALS/BIOLOGICAL RADIATION EFFECTS
Annual report, fiscal year 1976, 2:42118 (UCD-472-123)
LABORATORY ANIMALS/RADIATION DOSE DISTRIBUTIONS
Need for collection of quantitative distribution data for dosimetry and metabolic modeling, 2:42084 (CONF-770101-2)
LABORATORY ANIMALS/RADIONUCLIDE KINETICS
Plutonium problem in biological perspective (^{238}Pu and ^{239}Pu distribution and retention in man and laboratory animals and role of Transuranium Registry for personnel data compilation), 2:42094 (BNWL-2088)
LAKE SUPERIOR/SEDIMENTS
Impact of non-point pollution control on western Lake Superior. Red clay project-work plan. Work plan report May 74-Dec 78, 2:42009 (PB-255 293)
LAKES
See also LAKE SUPERIOR
LAKES/ECOLOGY
Decomposition in freshwater, 2:42004
LAND RECLAMATION/GOVERNMENT POLICIES
Strip mining in the corn belt: the destruction of high capability agricultural land for strip-minable coal in Illinois, 2:41642
LAND RECLAMATION/PLANNING
Development of pre-mining and reclamation plan rationale for surface coal mines. Volume I. The rationale for data acquisition. Final report, 2:40859 (PB-258042)
Development of pre-mining and reclamation plan rationale for surface coal mines. Volume II. Methods of data acquisition. Final report, 2:40860 (PB-258043)
LAND RECLAMATION/RESEARCH PROGRAMS
Land Reclamation Program. Annual report, July 1975-July 1976, 2:40852 (ANL-76-XX-42)
LAND RECLAMATION/STANDARDS
Criteria for developing pollution abatement programs for inactive and abandoned mine sites, 2:41998 (PB-258279)
LAND USE
Alternatives in energy conservation: the use of earth covered buildings (Conference; about 525 references), 2:41609 (NSF-RA-760006)
Comparison of energy consumption in earth-covered vs. non-earth-covered buildings, 2:41612 (NSF-RA-760006)
Earth-covered buildings and environmental impact, 2:41595 (NSF-RA-760006)
Terraset Elementary School, Reston, Virginia (Underground, solar-heated), 2:41616 (NSF-RA-760006)
University of Minnesota book store, 2:41614 (NSF-RA-760006)
University of Houston student center, 2:41615 (NSF-RA-760006)
Urban geotecture: the invisible features of the civic profile, 2:41589 (NSF-RA-760006)
LAND USE/AIR POLLUTION
Growth effects of major land use projects: Volume III. Summary. Final report, 2:41970 (PB-256204)
LAND USE/DECISION MAKING
Assessment of long-term environmental impacts by computer modeling, 2:42016
Computer simulation of environmental impact, 2:42017
LAND USE/ENVIRONMENTAL EFFECTS
Growth effects of major land use projects. Volume II. Compilation of land use based emission factors. Final report, 2:41997 (PB-255302)
LAND USE/LEGAL ASPECTS
Assessment of long-term environmental impacts by computer modeling, 2:42016
LANTHANUM ALLOYS/SORPTIVE PROPERTIES
Investigation of metal hydride materials as hydrogen reservoirs for metal-hydrogen batteries, 2:41162 (N-76-27667)
LANTHANUM PERCHLORATES/OSMOSIS
Isopiestic determination of the activity coefficients of some aqueous rare earth electrolyte solutions at 25°C. II. The rare earth perchlorates, 2:41874
LANTHANUM PERCHLORATES/THERMODYNAMIC PROPERTIES
Heats of dilution of some aqueous rare earth electrolyte solutions at 25°C. I. Rare earth perchlorates, 2:41873

LASER FUSION REACTORS/DESIGN
Laser and controlled thermonuclear fusion--2, 2:42309
LASER FUSION REACTORS/RESEARCH PROGRAMS
Current status of laser fusion research at Battelle, 2:42312
Laser fusion at KMSI/KMSF, 2:42311
LASER IMPLOSIONS
Dolphin high-power 12-channel laser unit for spherical heating of thermonuclear targets, 2:42221
Influence of laser design parameters on the hydrodynamics of microfusion plasmas, 2:42306 (JEN-351)
LASER IMPLOSIONS/ABSORPTION
Plasma experiments with 1.06-μm lasers at the Lawrence Livermore Laboratory, 2:42308 (UCRL-77943(Rev.2))
LASER IMPLOSIONS/OPTICAL SYSTEMS
Fast optics for the Rutherford laser compression experiments, 2:42307 (RL-76-147/B)
LASER IMPLOSIONS/RESEARCH PROGRAMS
Plasma experiments with 1.06-μm lasers at the Lawrence Livermore Laboratory, 2:42308 (UCRL-77943(Rev.2))
LASER IMPLOSIONS/REVIEWS
Laser fusion and laser isotope separation overview, 2:42310
LASER IMPLOSIONS/SCATTERING
Plasma experiments with 1.06-μm lasers at the Lawrence Livermore Laboratory, 2:42308 (UCRL-77943(Rev.2))
LASER ISOTOPE SEPARATION
Rare gas monohalide discharge studies. Final report, 2:41908 (UCRL-13713)
LASER ISOTOPE SEPARATION/REVIEWS
Laser fusion and laser isotope separation overview, 2:42310
LASER MATERIALS/EVALUATION
Evaluation of Nd:YVO_4 and Ho:Er:Tm:YVO_4 as pulse pumped q-switched lasers. Final report, 1 Jan 1974-1 Apr 1975, 2:41894 (AD-A-029916)
LASER MATERIALS/OPTICAL PROPERTIES
Chemical laser window measurements. Final report 7 May 1975-6 May 1976, 2:41893 (AD-A-028402)
LASER MIRRORS/MECHANICAL POLISHING
Cylindrical polishing technology development program. Final report, 3 Jun 1974-31 Jul 1975, 2:41898 (AD-A-034680)
LASER RADIATION/BIOLOGICAL EFFECTS
Biological effects of laser radiation (a bibliography with abstracts). Report for 1964-Jan 1977, 2:42137 (NTIS/PS-77/0028)
LASER RADIATION/FOCUSING
Array laser: a technique for the generation of ultra-high laser intensities, 2:41902 (LA-UR-75-2260)
LASER RADIATION/NONLINEAR PROBLEMS
Nonlinear laser spectroscopy, 2:41913
Resonantly enhanced, nonlinear generation of tunable, coherent, vacuum ultraviolet (vuv) light in atomic vapors, 2:41912
LASER-PRODUCED PLASMA
Dolphin high-power 12-channel laser unit for spherical heating of thermonuclear targets, 2:42221
Influence of laser design parameters on the hydrodynamics of microfusion plasmas, 2:42306 (JEN-351)
LASER-PRODUCED PLASMA/ELECTRIC CURRENTS
Spatial correlation between 1.06 μm laser irradiation and emitted current for a plane target, 2:42244
LASER-PRODUCED PLASMA/ENERGY TRANSFER
Effect of wavelength on absorption and ionization of laser-produced plasmas in magnetic fields with allowance for finite rate ionization and recombination, 2:42313
LASER-PRODUCED PLASMA/IONIZATION
Effect of wavelength on absorption and ionization of laser-produced plasmas in magnetic fields with allowance for finite rate ionization and recombination, 2:42313
LASER-RADIATION HEATING
Analytical investigation of the optical mixing of two laser beams of identical frequencies in a spatially homogeneous collisionless plasma, 2:42222
Dolphin high-power 12-channel laser unit for spherical heating of thermonuclear targets, 2:42221
LASERS
See also CARBON DIOXIDE LASERS
CHEMICAL LASERS
DYE LASERS
GAS LASERS
NEODYMIUM LASERS
RUBY LASERS
SEMICONDUCTOR LASERS
LASERS/MEETINGS
Third conference on the laser, 2:41909
LASERS/NUCLEAR PUMPING
Electron Boltzmann equation in a plasma generated by fission fragments, 2:42195 (N-76-29018)
LASERS/RESEARCH PROGRAMS
X ray laser research: guidelines and progress at the Naval Research Laboratory, 2:41910
LASERS/REVIEWS
Optics research, 1976:1. Semiannual technical summary report, 1 Jan-30 Jun 1976, 2:41896 (AD-A-034583)
LASERS/WAVELENGTHS
New developments in lasers at wavelengths of 3000 A and below, 2:41911
LASERS/X RADIATION
X ray laser research: guidelines and progress at the Naval Research Laboratory, 2:41910
LATTICES (REACTOR)
See REACTOR LATTICES
LAWRENCE LIVERMORE LABORATORY/COMPUTER NETWORKS
New design for interfacing computers to the Octopus network, 2:42334 (UCRL-79161)
LEAD/ABSORPTION SPECTROSCOPY
Determination of lead in petroleum and petroleum products by atomic absorption spectrometry with a carbon rod atomizer, 2:41013
Evaluation of a carbon-rod atomizer for routine determination of trace metals by atomic-absorption spectroscopy. Applications to analysis of lubricating oil and crude oil, 2:41016
LEAD/BIOLOGICAL EFFECTS
Cautionary tale of a lead hazard in recycling of waste, 2:42134
LEAD/ENVIRONMENTAL TRANSPORT
Health and Safety Laboratory environmental quarterly, December 1, 1976-March 1, 1977, 2:42085 (HASL-318)
LEAD/TITRATION
Lead traces titration in naphthas, 2:41000
LEAD/X-RAY EMISSION ANALYSIS
Investigation of size-dependent concentration of trace elements in aerosols emitted from the oil-fired heating plants, 2:40986 (N-76-27720)
LEAD SULFIDES/PHONONS
Inelastic neutron scattering studies of the phonon spectra of Chevrel phase superconductors ($SnMo_6S_8$, $PbMo_6S_8$, Mo_6Se_8, $Pb_{1.2}Mo_6Se_8$), 2:41808
LEAD SULFIDES/SUPERCONDUCTIVITY
Inelastic neutron scattering studies of the phonon spectra of Chevrel phase superconductors ($SnMo_6S_8$, $PbMo_6S_8$, Mo_6Se_8, $Pb_{1.2}Mo_6Se_8$), 2:41808
LEAVES/DECOMPOSITION
Decomposition in freshwater, 2:42004
LEUKEMIA VIRUS
See ONCOGENIC VIRUSES
LEUKOCYTES
See also LYMPHOCYTES
LEUKOCYTES/CELL PROLIFERATION
Leukocyte migration inhibition assay (Cell mediated immunity in dogs), 2:42065 (UCD-472-123)
LEVITATED TRAINS/PERFORMANCE TESTING
Electrodynamic levitated train. Erlangen large-scale test plant is being converted to long stator technology, 2:41731
LIGHT
See VISIBLE RADIATION
LIGHT NUCLEI/PROTON REACTIONS
Low fluxes of x rays. Final report (Interactions of high-energy protons with spacecraft materials and typical materials for scintillation detectors), 2:41936 (N-76-30279)
LIGHTING SYSTEMS/EFFICIENCY
Function and evaluation of air-conditioned luminaires--2, 2:41671
LIGHTING SYSTEMS/SAFETY STANDARDS
Present state and future prospects of development of coal pit lighting, 2:40891
LIGNITE/CAKING POWER
Active radicals containing oxygen and caking property of lignite, 2:40848
LIGNITE/PERMEABILITY
Rock mechanics aspects of in-situ gasification with special reference to Texas lignite, 2:40768 (MERC/SP-76/3)
LIMITERS/PERFORMANCE
Use of limiters made of graphite and boron carbide in the TFR machine, 2:42316 (EUR-CEA-FC-852)
LINEAR SCREW PINCH DEVICES/PLASMA INSTABILITY
The m = 1 motion of a screw pinch measured by external magnetic probes, 2:42245 (N-76-31015)
LINEAR THETA PINCH DEVICES/PLASMA CONFINEMENT
Study of flow and loss processes at the ends of a linear theta pinch. Progress report for the period June 1, 1976-May 31, 1977, 2:42212 (COO-4020-3)
LINEAR THETA PINCH DEVICES/PLASMA DIAGNOSTICS
Study of flow and loss processes at the ends of a linear theta pinch. Progress report for the period June 1, 1976-May 31, 1977, 2:42212 (COO-4020-3)
LIPIDS/CHEMICAL COMPOSITION
Monosomic analysis of fatty acid composition in embryo lipids of Zea mays L, 2:42033

LIQUEFIED NATURAL GAS/STORAGE
Automatic welding for an LNG storage tank of 9% nickel steel, 2:41049
LIQUEFIED NATURAL GAS/TRANSPORT
Ammonia leakage test, 2:41041
International gas transmission, 2:41042
Method for transporting liquefied natural gas (Patent; ships), 2:41048
LIQUID ASPHALT
See RESIDUAL FUELS
LIQUID CONTAMINATION MONITORS/ALARM SYSTEMS
Effluent and sanitary sewer monitors, 2:42013 (LA-6638-M)
LIQUID CONTAMINATION MONITORS/DESIGN
Effluent and sanitary sewer monitors, 2:42013 (LA-6638-M)
LIQUID METAL FAST BREEDER REACTORS
See LMFBR TYPE REACTORS
LIQUID METAL TEST FACILITIES
See TEST FACILITIES
LIQUID METALS/MATHEMATICAL MODELS
Model for liquid uranium and plutonium with implications on the adjacent solid phases, 2:41777
LIQUID WASTES/ENVIRONMENTAL EFFECTS
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
LIQUID WASTES/WASTE DISPOSAL
Utilities for underground structures, 2:41590 (NSF-RA-760006)
LIQUID-METAL MHD GENERATORS/LIQUID FLOW
Electrical engineering characteristics of MHD generators operating by emulsion, 2:41661
LITHIUM/ABSORPTION SPECTROSCOPY
Novel wet-digestion procedure for trace-metal analysis of coal by atomic absorption, 2:40836
LITHIUM/SOLUBILITY
Equilibrium pressure and solubility of hydrogen in liquid lithium, 2:42323
LITHIUM COMPOUNDS/ABSORPTION SPECTROSCOPY
Determination of lithium stearate in sebacate-based lubricants by atomic absorption, 2:41006
LITHIUM-SULFUR BATTERIES/CATHODES
Metallic sulfide additives for positive electrode material within a secondary electrochemical cell (Patent; Fe sulfide electrode with sulfide additives of Co, Ni, Cu, Ce, Mn), 2:41577
LITHIUM-SULFUR BATTERIES/RESEARCH PROGRAMS
High-performance batteries for off-peak energy storage and electric-vehicle propulsion. Progress report for the period July-September 1976 (Li-Al/Kcl-LiCl/Fes or FeS_2; tests of Li/TiS_2, Na/FeS_2, and $CaMg_2$/FeS cells), 2:41567 (ANL-76-98)
LIZARDS/HATCHING
Eggs and hatchlings of captive Dipsosaurus dorsalis, 2:42069
LMFBR TYPE REACTORS
See also CLINCH RIVER BREEDER REACTOR
EBR-2 REACTOR
FFTF REACTOR
PHENIX REACTOR
RAPSODIE REACTOR
SNR-1 REACTOR
LMFBR TYPE REACTORS/BREEDING BLANKETS
Radial blanket design and development. Quarterly progress report for period ending May 31, 1976, 2:41409 (WARD-RB-3045-14)
LMFBR TYPE REACTORS/CONTROL ELEMENTS
Control rod assembly for liquid metal fast breeder reactors, 2:41437 (RDT-E-6-33T)
LMFBR TYPE REACTORS/COOLANT CLEANUP SYSTEMS
Economical removal of sodium water reaction products (SWRP) from an LMFBR intermediate heat transport system (IHTS), 2:41417
LMFBR TYPE REACTORS/CORROSION PRODUCTS
Post-critical heat flux fouling by system corrosion products in a model sodium heated steam generator, 2:41423
LMFBR TYPE REACTORS/FLOWMETERS
New type sodium flow meter for fuel elements in nuclear power stations (LMFBR), 2:41415
LMFBR TYPE REACTORS/FUEL ASSEMBLIES
Heat transfer tests of an electrically heated 7-rod mock-up of an LMFBR radial blanket assembly, 2:41421
LMFBR TYPE REACTORS/FUEL CYCLE
Physical characteristics of fast power reactor fuel and their effect on the fuel cycle, 2:41396 (IAEA-CN-36/326)
Safety of the liquid metal cooled fast breeder reactor and aspects of its fuel cycle, 2:41529 (IAEA-CN-36/572)
LMFBR TYPE REACTORS/FUEL ELEMENTS
Advanced LMFBR core design. Fifth quarterly report, July-September 1976, 2:41387 (GEAP-14078-5)
Fast reactor fuel design and development, 2:41391 (IAEA-CN-36/64)
LMFBR TYPE REACTORS/FUEL MANAGEMENT
Critical experiments and analysis twenty-first quarterly report, October-December 1976, 2:41386 (GEAP-13771-21)
LMFBR TYPE REACTORS/FUEL PELLETS
Mechanical response of UO_2 subjected to transient heating, 2:41556
LMFBR TYPE REACTORS/FUEL PINS
Behaviour of mixed monocarbide and -nitride fuel under high power density, 2:41399 (IAEA-CN-36/369)
LMFBR TYPE REACTORS/FUEL RODS
Fuel rods vibration in fast breeder reactors, 2:41382 (CS-INIS-29)
LMFBR TYPE REACTORS/FUEL-CLADDING INTERACTIONS
Fuel-cladding mechanical interaction effects in fast reactor mixed oxide fuel, 2:41408 (WARD-OX-3045-28)
LMFBR TYPE REACTORS/GOVERNMENT POLICIES
Nontechnical issues associated with LMFBR energy centers, 2:41604 (ORAU/IEA(M)-76-15)
LMFBR TYPE REACTORS/HEAT EXCHANGERS
Heat transfer in tube bundles of heat exchangers with flow baffles induced forced mixing, 2:41418
LMFBR TYPE REACTORS/LOOSE PARTS MONITORING
Noise diagnostics for safety assessment. Quarterly progress report for October-December 1976, 2:41321 (ORNL/NUREG/TM-97)
LMFBR TYPE REACTORS/MELTDOWN
Laminar natural convection about downward facing heated blunt bodies to liquid metals, 2:41546
Postaccident heat removal--1. heat transfer within an internally heated, nonboiling liquid layer, 2:41549
Postaccident heat removal--2. heat transfer from an internally heated liquid to a melting solid, 2:41550
Role of Taylor instability on sublimation of a horizontal slab of dry ice, 2:41554
LMFBR TYPE REACTORS/MOLTEN METAL-WATER REACTIONS
Economical removal of sodium water reaction products (SWRP) from an LMFBR intermediate heat transport system (IHTS), 2:41417
Sodium-water reaction test facility (SWAT-3), 2:41548
LMFBR TYPE REACTORS/PIPE FITTINGS
Simplified inelastic (plastic and creep) analysis of pipe elbows subjected to inplane and out-of-plane bending, 2:41412
LMFBR TYPE REACTORS/PIPELINES
High-temperature piping design technology quarterly technical progress report, October-December 1976, 2:41378 (AI-ERDA-13191)
LMFBR TYPE REACTORS/PLANNING
Programme and current status of fast breeder reactor development in Japan, 2:41392 (IAEA-CN-36/164)
Status and programme of development of the fast breeder reactor systems in the Federal Republic of Germany, 2:41404 (IAEA-CN-36/497)
Status and programme for the fast breeder reactor in the UK, 2:41390 (IAEA-CN-36/54)
Status and program of development of the fast breeder reactor system in the U.S., 2:41401 (IAEA-CN-36/427)
USSR fast reactor development program and its current state, 2:41398 (IAEA-CN-36/356)
LMFBR TYPE REACTORS/PLUTONIUM RECYCLE
Pu utilization in fast-breeder and in light-water reactors in Italy, 2:41320 (IAEA-CN-36/577)
LMFBR TYPE REACTORS/PRIMARY COOLANT CIRCUITS
Caustic stress corrosion cracking, 2:41388 (HEDL-SA-1122)
Summary on experimental methods for statistical transient analysis of two-phase gas-liquid flow, 2:41312 (ANL-76-75)
LMFBR TYPE REACTORS/REACTOR ACCIDENTS
Evaluation of local accidents in LMFBR, 2:41527 (IAEA-CN-36/551)
LMFBR TYPE REACTORS/REACTOR COMPONENTS
Liquid Metal Engineering Center (LMEC). Annual technical progress report, January-December 1976 (LMFBR sodium component and instrumentation testing), 2:41405 (LMEC-77-1)
LMFBR TYPE REACTORS/REACTOR COOLING SYSTEMS
Sodium contamination measurement with plugging meter and hydrogen leak detection system, 2:41414
LMFBR TYPE REACTORS/REACTOR CORE DISRUPTION
LMFBR Aerosol Release and Transport Program. Quarterly progress report for October-December 1976, 2:41533 (ORNL/NUREG/TM-90)
LMFBR safety. 3. Review of current issues and bibliography of literature (1972-1974), 2:41532 (ORNL/NUREG/NSIC-131)
Potential for penetration of a hot vapor jet into a subcooled liquid, 2:41551
Stability of a submerged frozen crust, 2:41552
LMFBR TYPE REACTORS/REACTOR CORE RESTRAINTS
Core restraint development. Quarterly progress report for period ending November 30, 1976, 2:41407 (WARD-CR-3045-15)
LMFBR TYPE REACTORS/REACTOR CORES
Advanced LMFBR core design. Fifth quarterly report, July-September 1976, 2:41387 (GEAP-14078-5)

Core engineering sixtieth quarterly report, August-October 1976, 2:41385 (GEAP-10028-60)
LMFBR TYPE REACTORS/REACTOR INSTRUMENTATION
Temperature and voltage tests on MgO insulated coaxial cables, 2:41389 (HEDL-TME-76-66)
LMFBR TYPE REACTORS/REACTOR KINETICS
Coarse-mesh correction of the finite difference method for neutron diffusion calculations, 2:41416
Critical experiments and analysis twenty-first quarterly report, October-December 1976, 2:41386 (GEAP-13771-21)
LMFBR TYPE REACTORS/REACTOR SAFETY
European in-pile investigations on fast breeder reactor safety, 2:41519 (IAEA-CN-36/245)
LMFBR safety. 3. Review of current issues and bibliography of literature (1972-1974), 2:41532 (ORNL/NUREG/NSIC-131)
Mechanical response of UO_2 subjected to transient heating, 2:41556
Safety considerations in fast reactor fuel development, 2:41512 (IAEA-CN-36/18)
Safety of the liquid metal cooled fast breeder reactor and aspects of its fuel cycle, 2:41529 (IAEA-CN-36/572)
LMFBR TYPE REACTORS/SECONDARY COOLANT CIRCUITS
Creep and creep--rupture properties of $2^1/_4$Cr2Mo steel for fast breeder reactor in high temperature sodium, 2:41794
LMFBR TYPE REACTORS/SOCIO-ECONOMIC FACTORS
Nontechnical issues associated with LMFBR energy centers, 2:41604 (ORAU/IEA(M)-76-15)
LMFBR TYPE REACTORS/STEAM GENERATORS
Burn-out power in once-through tubular steam generators, 2:41410
Design considerations for systems subject to sodium/water reactions, 2:41413
Post-critical heat flux fouling by system corrosion products in a model sodium heated steam generator, 2:41423
Sodium heated steam generator tube wastage due to water/steam to sodium leaks--theory and correlation, 2:41420
Structural and thermal-hydraulic design of a sodium heated duplex bayonet tube steam generator, 2:41419
LMFBR TYPE REACTORS/TEST FACILITIES
Liquid Metal Engineering Center (LMEC). Annual technical progress report, January-December 1976 (LMFBR sodium component and instrumentation testing), 2:41405 (LMEC-77-1)
LMFBR TYPE REACTORS/TRANSIENTS
Preaccident modeling of an LMFBR plant for SSC-L, 2:41509 (BNL-NUREG-50602(Pt.1))
LNG
See LIQUEFIED NATURAL GAS
LOAD MANAGEMENT/ALGORITHMS
Formulation and computer methods of load flow studies, 2:41289
LOAD MANAGEMENT/MODIFICATIONS
Changes in an electric utility's fuel base, 2:41653
LOAD MANAGEMENT/OPTIMIZATION
Formulation and computer methods of load flow studies, 2:41289
LOCAL GALAXY
See MILKY WAY
LOOSE PARTS MONITORING/RESEARCH PROGRAMS
Noise diagnostics for safety assessment. Quarterly progress report for October-December 1976 (BWR, PWR, and LMFBR), 2:41321 (ORNL/NUREG/TM-97)
LOSS OF COOLANT/CRITICAL HEAT FLUX
Analysis of critical heat flux in flow reversal transients (PWR), 2:41545
LOSS OF COOLANT/HEAT TRANSFER
Two-dimensional analysis of conduction-controlled rewetting with precursory cooling, 2:41547
LOSS OF COOLANT/MATHEMATICAL MODELS
Analysis of loss of coolant accidents (BWR; PWR), 2:41515 (IAEA-CN-36/127)
LOUISIANA/NATURAL GAS FIELDS
List of Louisiana oil and gas fields and salt domes including the offshore areas showing code numbers and official abbreviations, 2:41646
LOUISIANA/OIL FIELDS
List of Louisiana oil and gas fields and salt domes including the offshore areas showing code numbers and official abbreviations, 2:41646
LOUISIANA/PETROLEUM DEPOSITS
The potential and economics of enhanced oil recovery. Final report, 2:40932 (PB-254991)
LOUISIANA/SALT DEPOSITS
List of Louisiana oil and gas fields and salt domes including the offshore areas showing code numbers and official abbreviations, 2:41646
LOW BTU GAS/MARKET
1976 ERDA in situ coal gasification program, 2:40746 (MERC/SP-76/3)
LOW BTU GAS/PURIFICATION
Utilization of low BTU gas from in-situ coal gasification for on-site power generation, 2:40773 (MERC/SP-76/3)
LOW BTU GAS/SYNTHESIS
Fluidized bed solids waste gasifier, 2:41172
LOW LEVEL COUNTERS/CALIBRATION
Summary of discussion calibration techniques and errors I, 2:42100 (BNWL-2088)
LOW-BETA PLASMA/ELECTRON BEAM INJECTION
Cross-field-current driven lower-hybrid instability and stochastic ion heating, 2:42216 (PPPL-1327)
LUBRICANTS
See also LUBRICATING OILS
LUBRICANTS/CHEMICAL ANALYSIS
Determination of lithium stearate in sebacate-based lubricants by atomic absorption, 2:41006
Determination of diisopropyl phosphite in sebacate-base lubricants. Determination of phosphorus in diisopropyl phosphite, 2:41007
Spectrophotometric determination of antimony in sebacate-base lubricants by the iodide method, 2:41008
LUBRICANTS/CHEMICAL PREPARATION
Lubricant chemistry, 2:40972
LUBRICANTS/CHEMICAL PROPERTIES
Lubricant chemistry, 2:40972
LUBRICANTS/PERFORMANCE
Boundary lubricity studies: structure-activity correlations in alkylpyridines, 2:41002
Investigation of the activity of cutting oil additives. III. Oils containing both organochlorine and organosulphur compounds, 2:41026
Preferential adsorption in the lubrication process of zinc dialkyldithiophosphate, 2:41009
LUBRICANTS/RESEARCH PROGRAMS
Petroleum derivatives. I. Current research, 2:40970
LUBRICANTS/STABILITY
Boundary lubrication of formulated C-ethers in air to 300°C. II. Organic additives, 2:41001
LUBRICATING OILS
See also WASTE OILS
LUBRICATING OILS/CHEMICAL ANALYSIS
Evaluation of a carbon-rod atomizer for routine determination of trace metals by atomic-absorption spectroscopy. Applications to analysis of lubricating oil and crude oil, 2:41016
LUBRICATING OILS/PERFORMANCE TESTING
Complex esters as antiwear agents, 2:41004
Effect of lubricant extreme-pressure additives on rolling-element fatigue life, 2:41010
Investigation of anti-wear additives under various loads and at different sliding speeds, 2:41003
LUBRICATING OILS/SOLVENT EXTRACTION
Deasphalt to get feed for lubes, 2:40950
LUBRICATING OILS/STABILITY
Service performance of steam-turbine oils: oxidation stability and the predominant causes of service degradation, 2:41005
LUMINOUS PAINTS/RADIOACTIVITY
Biological effects of low levels of radiation exposure (Radiation hazards to man from radioactive consumer products), 2:42077 (UR-3490-1072)
LUNAR MATERIALS/SPUTTERING
Mass fractionation of the lunar surface by solar wind sputtering, 2:42150 (N-76-31119)
LUNG CLEARANCE/MEETINGS
Air pollution and the lung, 2:42127
LUNGS
Preliminary evaluations of a high-purity germanium detector system for in vivo measurement of inhaled transuranium elements, 2:42113 (BNWL-2088)
LUNGS/RADIOISOTOPE SCANNING
Calibration techniques and error analysis for phoswich counting of actinide nuclides at Oak Ridge National Laboratory, 2:42096 (BNWL-2088)
Calibration for plutonium-238 lung counting at Mound Laboratory, 2:42101 (BNWL-2088)
Calibration techniques for the in vivo measurement of alpha-emitting actinides (In lungs), 2:42102 (BNWL-2088)
Determination of heavy elements in humans, 2:42099 (BNWL-2088)
Development of an anthropomorphic phantom for the calibration of external detectors for the in vivo measurement of plutonium, 2:42114 (BNWL-2088)
Effects of plutonium redistribution on lung counting, 2:42110 (BNWL-2088)
Error analysis and propagation of uncertainties for the measurement of inhaled transuranium elements, 2:42098 (BNWL-2088)
Estimation of lung and skeletal burdens of bone-seeking radionuclides in man from in vivo scintillation measurements of the thorax and the head, 2:42107 (BNWL-2088)
In vivo plutonium measurement at the Battelle-Northwest whole body center, 2:42104 (BNWL-2088)

LLL plutonium lung counter calibration and discussion of errors, 2:42105 (BNWL-2088)
Measurement of transuranic elements in vivo at CRNL (Personnel monitoring at nuclear fuel fabrication plant), 2:42103 (BNWL-2088)
Methods for the assay of plutonium in vivo: what are the alternatives (^{238}Pu, ^{239}Pu, and ^{241}Am assay in vivo), 2:42108 (BNWL-2088)
Present status of and future plans for ITRI's human and dog chest counting facilities, 2:42106 (BNWL-2088)
Role of chest counting in personnel dosimetry (^{238}Pu and ^{239}Pu lung counting of personnel), 2:42095 (BNWL-2088)
Summary of discussion calibration techniques and errors I, 2:42100 (BNWL-2088)
Ultrasonic measurement techniques used at LLL for determining chest wall thickness and organ shapes (Monitoring personnel for transuranic element deposition in lungs), 2:42112 (BNWL-2088)

LURGI PROCESS/ECONOMICS
Economic comparison of producing SNG by Lawrence Livermore Laboratory's in situ coal gasification process with Lurgi aboveground coal gasification, 2:40758 (MERC/SP-76/3)

LUTETIUM PERCHLORATES/OSMOSIS
Isopiestic determination of the activity coefficients of some aqueous rare earth electrolyte solutions at 25°C. II. The rare earth perchlorates, 2:41874

LUTETIUM PERCHLORATES/THERMODYNAMIC PROPERTIES
Heats of dilution of some aqueous rare earth electrolyte solutions at 25°C. I. Rare earth perchlorates, 2:41873

LWGR TYPE REACTORS
See also BELOYARSK-2 REACTOR
N-REACTOR

LWGR TYPE REACTORS/PLANNING
Uranium-graphite reactor development in the USSR, 2:41360 (IAEA-CN-36/586)

LYMPHOBLASTOMAS
See LYMPHOMAS

LYMPHOCYTES/ABUNDANCE
Quantitation of human T-lymphocytes in blood: use of automatic smearing instrument for preparing fixed slides of E-rosettes, 2:42042

LYMPHOCYTES/BIOLOGICAL EFFECTS
Increasing the efficiency of azide mutagenesis in barley, 2:42043 (RLO-2221-T2-31)

LYMPHOCYTES/BIOLOGICAL RADIATION EFFECTS
Inhibition of erythroid cell growth in irradiated mice by allogeneic lymphoid cells: specificity of the response (X Radiation), 2:42071

LYMPHOCYTES/CELL CULTURES
Increasing the efficiency of azide mutagenesis in barley, 2:42043 (RLO-2221-T2-31)

LYMPHOCYTES/CELL PROLIFERATION
Improved methods for reducing calcium and magnesium concentrations in tissue culture medium: application to studies of lymphoblast proliferation in vitro, 2:42053
Lymphoid colonies (Cell cultures on methylcellulose culture system), 2:42039 (UCD-472-123)

LYMPHOCYTES/COMPARATIVE EVALUATIONS
Human cord blood lymphocytes. Ultrastructural and immunologic surface marker characteristics: a comparison with B- and T-cell lymphomas, 2:42041

LYMPHOCYTES/ELECTRON MICROSCOPY
Human cord blood lymphocytes. Ultrastructural and immunologic surface marker characteristics: a comparison with B- and T-cell lymphomas, 2:42041

LYMPHOCYTES/IMMUNE REACTIONS
Inhibition of erythroid cell growth in irradiated mice by allogeneic lymphoid cells: specificity of the response (X Radiation), 2:42071

LYMPHOGRANULOMAS
See LYMPHOMAS

LYMPHOID CELLS
See LYMPHOCYTES

LYMPHOMAS
Human cord blood lymphocytes. Ultrastructural and immunologic surface marker characteristics: a comparison with B- and T-cell lymphomas, 2:42041

M

MAGNESIUM/ABSORPTION SPECTROSCOPY
Determination of trace metals in crude oils by nonflame atomic absorption spectroscopy, 2:41014
Novel wet-digestion procedure for trace-metal analysis of coal by atomic absorption, 2:40836

MAGNESIUM ALLOYS/MECHANICAL PROPERTIES
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)

MAGNESIUM ALLOYS/THERMAL CONDUCTIVITY
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)

MAGNET COILS/DESIGN
Dynamic constraints on inductive energy storage, 2:42298

MAGNET COILS/OPTIMIZATION
Optimum design of the poloidal field coils of a large fusion device, 2:42292 (JAERI-M-6451)

MAGNET COILS/STRESSES
Stress distributions of coils for toroidal magnetic field, 2:42294 (N-76-25020)

MAGNETIC BAYS/INTERPLANETARY MAGNETIC FIELDS
Multisatellite study of auroral zone phenomena. Part 2: observations during a substorm period on 11 November 1969, 2:42192 (N-76-27758)

MAGNETIC COILS
See MAGNET COILS

MAGNETIC ENERGY STORAGE
See also SUPERCONDUCTING MAGNETS

MAGNETIC ENERGY STORAGE/ELECTRIC FUSES
Magnetic energy storage system used in ZT-1, 2:42299

MAGNETIC ENERGY STORAGE/SUPERCONDUCTING MAGNETS
Results of experiments with a superconductive prototype coil for a toroidal magnet, 2:42300

MAGNETIC FIELD CONFIGURATIONS/COMPUTER CALCULATIONS
Computer code for study of the error magnetic fields based on a model of practical poloidal field coils in a large tokamak, 2:42293 (JAERI-M-6470)

MAGNETIC MIRROR CONFIGURATIONS/PLASMA CONFINEMENT
Conduction heat loss scaling in open field line geometries, 2:42217 (PPPL-1329)

MAGNETIC MIRROR TYPE REACTORS/CYCLOTRON INSTABILITY
Plasma thermonuclear cyclotron-magnetoacoustic instability, 2:42248

MAGNETIC STORMS
Report on the geophysical description and available data associated with rocket PF-NH-89 (IC 507.11-2a), 2:42189 (AD-A-034731)

MAGNETIC STORMS/ORIGIN
Polar aurora in the magnetosphere, 2:42193 (N-76-27751)

MAGNETIC SURFACES
See MAGNETIC FIELD CONFIGURATIONS

MAGNETOSHEATH/LONG WAVE RADIATION
Terrestrial kilometric radiation: 2-emission from the magnetospheric cusp and dayside magnetosheath, 2:42191 (N-76-27752)

MAGNETOSPHERE/AURORAE
Polar aurora in the magnetosphere, 2:42193 (N-76-27751)

MAGNETOSPHERE/HOT PLASMA
Polar aurora in the magnetosphere, 2:42193 (N-76-27751)

MAGNETOSPHERE/PLASMA WAVES
Waves and instabilities in steady-state high-beta plasmas. Final report 15 May 72-30 Jun 76, 2:42254 (AD-A-030924)

MAGNETOSPHERE/SOLAR RADIATION
Multi-satellite attitude prediction program/Orbiting Solar Observatory-8 (MSAP/OSO-8) operating guide, 2:42164 (N-76-27304)

MAIZE/BIOCHEMISTRY
Monosomic analysis of fatty acid composition in embryo lipids of Zea mays L, 2:42033

MAIZE/SOLAR DRYING
Solar energy applications in agriculture: potential, research needs, and adoption strategies, summary and recommendations, 2:41217 (PB-255928)

MAMMALS
See also DOGS

MAMMALS/FOOD CHAINS
Ecology of intertidal benches of Amchitka Island, Alaska. Final summary report, August 1, 1974-December 31, 1974 (Dominance of sea otters), 2:41994 (RLO-2225-T36-1)

MAMMALS/IMMUNITY
Studies in developmental immunogenetics. Annual progress report, 2:42062 (CALT-767P6-X11)

MAMMALS/POPULATION DYNAMICS
Ecology of intertidal benches of Amchitka Island, Alaska. Final summary report, August 1, 1974-December 31, 1974 (Dominance of sea otters), 2:41994 (RLO-2225-T36-1)

MAN
See also PATIENTS
PERSONNEL

MAN/BIOLOGICAL RADIATION EFFECTS
Biological effects of low levels of radiation exposure (Radiation hazards to man from radioactive consumer products), 2:42077 (UR-3490-1072)
MAN/LOW DOSE IRRADIATION
Biological effects of low levels of radiation exposure (Radiation hazards to man from radioactive consumer products), 2:42077 (UR-3490-1072)
MANGANESE/ABSORPTION SPECTROSCOPY
Novel wet-digestion procedure for trace-metal analysis of coal by atomic absorption, 2:40836
MANGANESE/MINERAL CYCLING
Exchange of manganese, iron, copper, and zinc between dissolved and particulate forms in the Newport River estuary, North Carolina, 2:42003 (RLO-2227-T12-71)
MANGANESE 54/COSMOCHEMISTRY
Cosmogenic radionuclides in stone meteorites, 2:42173 (N-76-25115)
MANUFACTURING/ENERGY ACCOUNTING
Energy embodied in goods, 2:41654 (ORAU/IEA(M)-77-6)
MARCOULE PHENIX REACTOR
See PHENIX REACTOR
MARICULTURE
See AQUACULTURE
MARINE TRANSPORT/DIESEL ENGINES
Cyclic temperature fluctuations in marine diesel combustion chamber walls, 2:41721
MARS PLANET/PLANETARY MAGNETOSPHERES
Polar aurora in the magnetosphere, 2:42193 (N-76-27751)
MARYLAND/NUCLEAR POWER PLANTS
Maryland Power Plant Siting Project: an application of the ORNL-Land Use Screening Procedure, 2:41496 (ORNL/NUREG/TM-79)
MASS SPECTROMETERS/RESOLUTION
Rocket-borne time-of-flight mass spectrometry, 2:42184 (N-76-28723)
MASSACHUSETTS/REACTOR SITES
Probabilistic and statistical models for seismic risk analysis (Nuclear power plants), 2:41537 (PB-259188)
MATERIALS
Annual technical report, July 1, 1975-June 30, 1976 (Materials Research Lab., Univ. of Chicago), 2:41755 (AD-A-028846)
MATERIALS/RESEARCH PROGRAMS
Materials research at Stanford University. Annual report, 1 Jul 1975-30 Jun 1976, 2:41862 (N-76-30026)
MATERIALS RECOVERY/PLANNING
Implementing 'best management practices' for residuals: the waste exchange, 2:41696 (PB-258068)
MATHEMATICS
See also STATISTICS
MATHEMATICS/OPTIMIZATION
Systems Optimization Project. Progress report, 1 October 1975-30 June 1976 (Systems Optimization Lab., Dept. of Operations Research, Stanford Univ.), 2:42331 (SU-326P18X10)
MATHEMATICS/RESEARCH PROGRAMS
Extension of quasi-Newton methods to constrained optimization and to general systems of nonlinear equations and inequalities. Progress report, February 1, 1976-January 31, 1977 (Rice Univ.), 2:42328 (ORO-5046-1)
MAXWELL-BOLTZMANN EQUATION
See BOLTZMANN EQUATION
MEAT/RADIOACTIVITY
Result of the assay of radiation sterilized beef for induced radioactivity. Technical report, 2:42075 (AD-A-030785)
MEAT/RADIOSTERILIZATION
Result of the assay of radiation sterilized beef for induced radioactivity. Technical report, 2:42075 (AD-A-030785)
MELATONIN/BIOLOGICAL EFFECTS
Influence of melatonin on erythropoiesis, 2:42030
Melatonin action during hypobaric hypoxia, 2:42031
MELTDOWN
Properties of light water reactor core melts, 2:41555
MELTDOWN/AFTER-HEAT REMOVAL
Postaccident heat removal--1. heat transfer within an internally heated, nonboiling liquid layer, 2:41549
Postaccident heat removal--2. heat transfer from an internally heated liquid to a melting solid, 2:41550
MELTDOWN/BUBBLES
Role of Taylor instability on sublimation of a horizontal slab of dry ice, 2:41554
MELTDOWN/LAMINAR FLOW
Laminar natural convection about downward facing heated blunt bodies to liquid metals (LMFBR), 2:41546
MELTDOWN/NATURAL CONVECTION
Laminar natural convection about downward facing heated blunt bodies to liquid metals (LMFBR), 2:41546
MEMBRANES
See also CELL MEMBRANES
MEMBRANES/MOLECULAR BIOLOGY
Direct methods for the analysis of lamellar neutron diffraction from oriented multilayers: a difference patterson deconvolution approach, 2:42020 (BNL-50453)
Neutron diffraction studies of oriented retinal rods, 2:42022 (BNL-50453)
MEMBRANES/MOLECULAR STRUCTURE
Neutron diffraction studies of biological membranes and membrane components, 2:42019 (BNL-50453)
Neutron diffraction studies of nerve myelin, 2:42021 (BNL-50453)
MEMBRANES/NEUTRON DIFFRACTION
Direct methods for the analysis of lamellar neutron diffraction from oriented multilayers: a difference patterson deconvolution approach, 2:42020 (BNL-50453)
Neutron diffraction studies of biological membranes and membrane components, 2:42019 (BNL-50453)
Neutron diffraction studies of nerve myelin, 2:42021 (BNL-50453)
Neutron diffraction studies of oriented retinal rods, 2:42022 (BNL-50453)
MEMBRANES/STRUCTURAL CHEMICAL ANALYSIS
Neutron diffraction analysis of the structure of retinal photoreceptor membranes and rhodopsin, 2:42018 (BNL-50453)
MEMORY DEVICES/MATHEMATICAL MODELS
"Almost-exact" solution to the N-processor, M-memory bandwidth problem. Technical report No. 117, 2:42333 (SU-SEL-76-025)
MERCAPTANS
See THIOLS
MERCURY/ENVIRONMENTAL TRANSPORT
Trace element geochemistry of the South Atlantic Bight. Progress report, June 1, 1976-May 31, 1977, 2:42147 (SRO-890-2)
MERCURY 203/CLEARANCE
Methylmercury movements across the perfused guinea pig placenta in late gestation (Tritium, ^{125}I, ^{203}Hg), 2:42058
MERCURY COMPOUNDS/AEROSOL MONITORING
Gas chromatographic analysis of air pollutants, 2:41985
MERCURY PLANET/PLANETARY MAGNETOSPHERES
Polar aurora in the magnetosphere, 2:42193 (N-76-27751)
MESONS/PARTICLE PRODUCTION
Threshold effects in annihilation processes, 2:42196 (N-76-27996)
METAL INDUSTRY/ENERGY ACCOUNTING
Energy embodied in goods, 2:41654 (ORAU/IEA(M)-77-6)
METAL INDUSTRY/ENERGY DEMAND
Solving the coking coal problem, 2:40735
METAL INDUSTRY/ENERGY SHORTAGES
Solving the coking coal problem, 2:40735
METAL-GAS BATTERIES/CATHODES
Life capability of the silver electrode in alkaline electrochemical cells (Ag-H_2), 2:41576 (N-76-28648)
Oxygen evolution on semiconducting oxides (Air), 2:41578
METAL-GAS BATTERIES/HYDROGEN STORAGE
Investigation of metal hydride materials as hydrogen reservoirs for metal-hydrogen batteries, 2:41162 (N-76-27667)
METAL-NONMETAL BATTERIES
See also SODIUM-SULFUR BATTERIES
METAL-NONMETAL BATTERIES/RESEARCH PROGRAMS
High-performance batteries for off-peak energy storage and electric-vehicle propulsion. Progress report for the period July-September 1976 (Li-Al/Kcl-LiCl/Fes or FeS_2; tests of Li/TiS_2, Na/FeS_2, and $CaMg_2$/FeS cells), 2:41567 (ANL-76-98)
METALS
See also LIQUID METALS
TRANSITION ELEMENTS
METALS/CUTTING
Investigation of the activity of cutting oil additives. III. Oils containing both organochlorine and organosulphur compounds, 2:41026
METALS/PHYSICAL RADIATION EFFECTS
On the analogy between thermally and irradiation induced creep. Summary report, 2:41818 (AD-A-034885)
METEOROLOGY/BIBLIOGRAPHIES
Time series forecasting and prediction (a bibliography with abstracts). Report for 1964-Jan 1977, 2:41666 (NTIS/PS-77/0042)
METEOROLOGY/RESEARCH PROGRAMS
Radiological and Environmental Research Division annual report. Part IV. Atmospheric physics. January-December 1975, 2:41950 (ANL-75-60(Pt.4))
METER WAVE RADIATION
See RADIOWAVE RADIATION
METHANATION
Investigation of converting the product of coal gasification to methane by the action of microorganisms: Phase I. Third quarterly report, May 1, 1976-August 1, 1976, 2:41169 (FE-2203-12)
METHANE
Feasibility of combined determination of the natural and residual methane content of a coal seam, the methane pressure in the

seam, the sorption isotherms, and the gas emission kinetics, 2:40817
METHANE/BIOSYNTHESIS
Investigation of converting the product of coal gasification to methane by the action of microorganisms: Phase I. Third quarterly report, May 1, 1976-August 1, 1976, 2:41169 (FE-2203-12)
METHANE/CHEMICAL REACTION YIELD
Effects of heat and radiation on Gasbuggy chimney gas, 2:41039
METHANE/DESORPTION
Effect of mining on methane emission and concentration in return air, 2:40889
METHANE/GAS FLOW
Longwall gob degasification with surface ventilation boreholes above the lower Kittanning coalbed. Report of investigations, 2:40881 (PB-262189)
METHANE/OXIDATION
Research on electrochemical energy conversion systems. Final technical report, 1 Jul 1975-30 Jun 1976 (Trifluoromethanesulfonic acid electrolyte), 2:41663 (AD-A-034454)
METHANE/PYROLYSIS
Kinetics of the formation of pyrocarbon from methane, 2:41168
METHANE/SAMPLING
Regional air pollution study: quality assurance audits. Final report, 2:41967 (PB-255313)
METHANOL/PRODUCTION
Assessment of very high-temperature reactors in process applications. Appendix III. Engineering evaluation of process heat applications for very-high temperature reactors, 2:40788 (ORNL/TM-5411)
Economics of manufacturing synthesis gas produced by underground coal gasification, 2:40757 (MERC/SP-76/3)
METHEMOGLOBIN/RADIOLYSIS
Pulse radiolytic investigation of single heme group reduction in human methemoglobin, 2:42072
METHYLMERCURY/BIOCHEMICAL REACTION KINETICS
Methylmercury movements across the perfused guinea pig placenta in late gestation (Tritium, ^{125}I, ^{203}Hg), 2:42058
MICE/BIOLOGICAL RADIATION EFFECTS
Hematopoietic effects (Effects of internal ^{90}Sr and ^{226}Ra radiation, whole-body γ irradiation, and i.v.-administered fly ash silica particles), 2:42081 (UCD-472-123)
MICHIGAN/ENERGY SUPPLIES
Crude supply alternatives for the northern tier states. Volume I. Executive summary, 2:41643 (PB-255992)
Crude supply alternatives for the northern tier states. Volume II. Technical report, 2:41644 (PB-255993)
MICROBIAL FLORA
See MICROORGANISMS
MICROFLORA
See MICROORGANISMS
MICROORGANISMS
See also BACTERIA
VIRUSES
MICROORGANISMS/GROWTH
Iodine to control microbiological growth in fuel storage basin water, 2:41109 (ICP-1109)
MICROSPHERES/FABRICATION
Fusion fuel pellet and method for its fabrication (Patent), 2:41153
Thermonuclear fuel and its preparation process (Patent), 2:41151
Thermonuclear fuel and preparation process (Patent), 2:41150
MICROWAVE EQUIPMENT/RESEARCH PROGRAMS
Materials research at Stanford University. Annual report, 1 Jul 1975-30 Jun 1976, 2:41862 (N-76-30026)
MICROWAVE RADIATION/BIOLOGICAL EFFECTS
Quadrennial report of the division of biological effects, 1971-1974, 2:42078 (PB-258436)
MIDDLE EAST/PETROLEUM INDUSTRY
Middle East oil, 2:41645
MILITARY FACILITIES/BIOMASS PLANTATIONS
Feasibility of meeting the energy needs of army bases with self-generated fuels derived from solar energy plantations. Final report, 2:41196 (AD-A-031163)
Feasibility of meeting the energy needs of army bases with self-generated fuels derived from solar energy plantations (Appendices D, E, F, G, and H). Final report, 2:41197 (AD-A-031211)
MILITARY FACILITIES/FUELS
Feasibility of meeting the energy needs of army bases with self-generated fuels derived from solar energy plantations. Final report, 2:41196 (AD-A-031163)
MILK/RADIOACTIVITY
Appendix to health and safety laboratory environmental quarterly (Tabulated data on fallout radioactivity in environment), 2:41987 (HASL-318(App.))
MILKY WAY/MASERS
Powerful galactic masers, 2:42162 (N-76-25116)
MILLSTONE-1 REACTOR/ENVIRONMENTAL EFFECTS
Evaluation of Millstone Nuclear Power Plant, Environmental Impact prediction, based on monitoring programs, 2:41313 (BNWL-2152)
MILLSTONE-1 REACTOR/ENVIRONMENTAL IMPACTS
Evaluation of nuclear power plant environmental impact prediction, based on monitoring programs. Summary and recommendations, 2:41492 (BNWL-2153)
MILLSTONE-1 REACTOR/REACTOR OPERATION
Annual operating report: 1 January-31 December 1976, 2:41429 (DOCKET-50245-956)
MINERAL OIL
See LUBRICANTS
MINERAL OILS/CHEMICAL ANALYSIS
Coulometric micro-determination of sulphur and chloride in mineral oils, deposits, and solvent-extraction residues, 2:41019
MINERS/EDUCATION
Concept feasibility study for training equipment to improve coal productivity. Volume I. Final report, 2:40876 (PB-254863)
MINES
See also COAL MINES
UNDERGROUND SPACE
URANIUM MINES
MINES/LAND RECLAMATION
Criteria for developing pollution abatement programs for inactive and abandoned mine sites, 2:41998 (PB-258279)
MINES/WATER POLLUTION CONTROL
Inactive and abandoned underground mines. Water pollution prevention and control, 2:42011 (PB-258263)
MINING EQUIPMENT
See also CONVEYORS
Innovations and trends in face supports at the international mining exposition 1976, 2:40893
Roadheading technique at the 9th World Mining Congress, 2:40897
MINING EQUIPMENT/COMPARATIVE EVALUATIONS
Study of continuous face haulage systems. Final report, 2:40899 (PB-255841)
MINING EQUIPMENT/DESIGN
Coal cutting with a disk, 2:40885
MINING EQUIPMENT/FABRICATION
Survey of equipment manufacturing research and development needs. Final report, 2:40875 (PB-254768)
MINING EQUIPMENT/SAFETY
Study of low coal canopy concepts. Final Report, 17 Jun 1974-20 Feb 1975, 2:40872 (PB-254301)
MINING EQUIPMENT/SAFETY ENGINEERING
Development of protective canopy concepts for underground rail haulage equipment. Research report, 2:40873 (PB-254504)
MINNESOTA/ENERGY SUPPLIES
Crude supply alternatives for the northern tier states. Volume I. Executive summary, 2:41643 (PB-255992)
Crude supply alternatives for the northern tier states. Volume II. Technical report, 2:41644 (PB-255993)
MINNESOTA/SCHOOL BUILDINGS
University of Minnesota book store (95% below grade level), 2:41614 (NSF-RA-760006)
MISSILES/IMPACT TESTS
Numerical simulation of tornado-borne missile impact on fuel reprocessing and fabrication plants, 2:41881 (UCRL-52223)
MISSOURI/AIR POLLUTION
Measurements of atmospheric turbidity in an arc downwind of St. Louis, 2:41955 (ANL-75-60(Pt.4))
MISSOURI/AIR QUALITY
Regional air pollution study: quality assurance audits. Final report, 2:41967 (PB-255313)
MISSOURI/METEOROLOGY
Measurements of atmospheric turbidity in an arc downwind of St. Louis, 2:41955 (ANL-75-60(Pt.4))
Structure of the urban moisture field (St. Louis urban area), 2:41957 (ANL-75-60(Pt.4))
MIUS
(Modular Integrated Utility Systems.)
Coal technology program progress report for January 1977, 2:40731 (ORNL/TM-5819)
MODELS (PLASMA)
See PLASMA SIMULATION
MOLDS
See FUNGI
MOLTEN METAL-WATER REACTIONS
Economical removal of sodium water reaction products (SWRP) from an LMFBR intermediate heat transport system (IHTS), 2:41417
MOLTEN METAL-WATER REACTIONS/TEST FACILITIES
Sodium-water reaction test facility (SWAT-3), 2:41548
MOLTEN SALT REACTORS/FUEL CYCLE
MSR (Pu converters) and MSBRs in commercial nuclear power stations, 2:41400 (IAEA-CN-36/424)

MOLTEN SALT REACTORS/PLANNING
MSR (Pu converters) and MSBRs in commercial nuclear power stations, 2:41400 (IAEA-CN-36/424)
MOLTEN SALTS/PHASE DIAGRAMS
Theoretical concepts useful in the calculation or storage of phase diagrams of ionic systems, 2:41863 (CONF-770116-1)
MOLYBDENUM/COATINGS
Electrodeposition of titanium diboride coatings. Report of investigations 1976, 2:41816 (PB-257 384)
MOLYBDENUM/DEUTERON REACTIONS
Proton sputtering. Final report (500 eV to 8 keV), 2:42318 (ORO-3557-15)
MOLYBDENUM/PROTON REACTIONS
Proton sputtering. Final report (500 eV to 8 keV), 2:42318 (ORO-3557-15)
MOLYBDENUM/SPUTTERING
Proton sputtering. Final report (500 eV to 8 keV), 2:42318 (ORO-3557-15)
MOLYBDENUM/X-RAY EMISSION ANALYSIS
Investigation of size-dependent concentration of trace elements in aerosols emitted from the oil-fired heating plants, 2:40986 (N-76-27720)
MOLYBDENUM 100 TARGET/NEUTRON REACTIONS
Average neutron resonance parameters and radiative capture cross sections for the isotopes of molybdenum (3 to 90 keV), 2:42204
MOLYBDENUM 92 TARGET/NEUTRON REACTIONS
Average neutron resonance parameters and radiative capture cross sections for the isotopes of molybdenum (3 to 90 keV), 2:42204
MOLYBDENUM 94 TARGET/NEUTRON REACTIONS
Average neutron resonance parameters and radiative capture cross sections for the isotopes of molybdenum (3 to 90 keV), 2:42204
MOLYBDENUM 95 TARGET/NEUTRON REACTIONS
Average neutron resonance parameters and radiative capture cross sections for the isotopes of molybdenum (3 to 90 keV), 2:42204
MOLYBDENUM 96 TARGET/NEUTRON REACTIONS
Average neutron resonance parameters and radiative capture cross sections for the isotopes of molybdenum (3 to 90 keV), 2:42204
MOLYBDENUM 97 TARGET/NEUTRON REACTIONS
Average neutron resonance parameters and radiative capture cross sections for the isotopes of molybdenum (3 to 90 keV), 2:42204
MOLYBDENUM 98 TARGET/NEUTRON REACTIONS
Average neutron resonance parameters and radiative capture cross sections for the isotopes of molybdenum (3 to 90 keV), 2:42204
MOLYBDENUM ALLOYS
See also INCONEL 718
STAINLESS STEEL-316
MOLYBDENUM ALLOYS/CORROSION
The role of passive film growth kinetics and properties in stress corrosion and crevice corrosion susceptibility. Technical summary report No. 7, Oct 1975-Nov 1976, 2:41812 (AD-A-034723)
MOLYBDENUM ALLOYS/CRYSTAL-PHASE TRANSFORMATIONS
Shear martensitic transformation in uranium alloys during quenching, plastic deformation and low temperature annealing, 2:41776
MOLYBDENUM ALLOYS/FORGING
High-toughness titanium alloy development. Final engineering report Jan 1975-May 1976, 2:41756 (AD-A-030274)
MOLYBDENUM ALLOYS/HEAT TREATMENTS
High-toughness titanium alloy development. Final engineering report Jan 1975-May 1976, 2:41756 (AD-A-030274)
MOLYBDENUM ALLOYS/PHONONS
Phonon anomalies in transition metals, alloys, and compounds, 2:41809
MOLYBDENUM ALLOYS/SUPERCONDUCTIVITY
Phonon anomalies in transition metals, alloys, and compounds, 2:41809
MOLYBDENUM ALLOYS/THERMOELECTRIC PROPERTIES
Thermoelectric properties of solid solutions based on uranium and thorium, 2:41805
MOLYBDENUM SELENIDES/PHONONS
Inelastic neutron scattering studies of the phonon spectra of Chevrel phase superconductors ($SnMo_6S_8$, $PbMo_6S_8$, Mo_6Se_8, $Pb_{1-x}Mo_6Se_8$), 2:41808
MOLYBDENUM SELENIDES/SUPERCONDUCTIVITY
Inelastic neutron scattering studies of the phonon spectra of Chevrel phase superconductors ($SnMo_6S_8$, $PbMo_6S_8$, Mo_6Se_8, $Pb_{1-x}Mo_6Se_8$), 2:41808
MOLYBDENUM SULFIDES/PHONONS
Inelastic neutron scattering studies of the phonon spectra of Chevrel phase superconductors ($SnMo_6S_8$, $PbMo_6S_8$, Mo_6Se_8, $Pb_{1-x}Mo_6Se_8$), 2:41808
MOLYBDENUM SULFIDES/SUPERCONDUCTIVITY
Inelastic neutron scattering studies of the phonon spectra of Chevrel phase superconductors ($SnMo_6S_8$, $PbMo_6S_8$, Mo_6Se_8, $Pb_{1-x}Mo_6Se_8$), 2:41808
MONITORS (FAILED ELEMENTS)
See FAILED ELEMENT MONITORS
MONITORS (REACTOR)
See REACTOR CONTROL SYSTEMS
MONKEYS/BIOLOGICAL RADIATION EFFECTS
Fractionated x-irradiation damage to developing ovaries in the bonnet monkey (Macaca radiata), 2:42080 (UCD-472-123)
MONTANA/COAL MINING
A comparative case study of the impact of coal development on the way of life of people in the coal areas of eastern Montana and northeastern Wyoming. Final report, 2:40856 (PB-254924)
MONTANA/ENERGY SUPPLIES
Crude supply alternatives for the northern tier states. Volume I. Executive summary, 2:41643 (PB-255992)
Crude supply alternatives for the northern tier states. Volume II. Technical report, 2:41644 (PB-255993)
MONTANA/RURAL POPULATIONS
A comparative case study of the impact of coal development on the way of life of people in the coal areas of eastern Montana and northeastern Wyoming. Final report, 2:40856 (PB-254924)
MONTICELLO REACTOR/ENVIRONMENTAL IMPACTS
Evaluation of nuclear power plant environmental impact prediction, based on monitoring programs. Summary and recommendations, 2:41492 (BNWL-2153)
MOON/OVERBURDEN
Mass fractionation of the lunar surface by solar wind sputtering, 2:42150 (N-76-31119)
MORPHOLOGICAL CHANGES/DATA ANALYSIS
Intrinsic material properties of the erythrocyte membrane indicated by mechanical analysis of deformation, 2:42040
MORPHOLOGY
See MORPHOLOGICAL CHANGES
MOTOR VEHICLE ACCIDENTS/BIBLIOGRAPHIES
Time series forecasting and prediction (a bibliography with abstracts). Report for 1964-Jan 1977, 2:41666 (NTIS/PS-77/0042)
MUNICIPAL WASTES
See also REFUSE DERIVED FUELS
MUNICIPAL WASTES/COMBUSTION
Power from urban refuse, 2:41260
MUSCLES
See also MYOBLASTS
MYOCARDIUM
MUSCLES/MOLECULAR BIOLOGY
Neutron diffraction studies of vertebrate striated muscle, 2:42024 (BNL-50453)
MUSCLES/NEUTRON DIFFRACTION
Neutron diffraction studies of vertebrate striated muscle, 2:42024 (BNL-50453)
MUTAGENS
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
MUTANTS/BIOCHEMISTRY
Mutants of the Chinese hamster ovary cell line requiring analine and glutamate, 2:42047
MYELIN/MOLECULAR STRUCTURE
Neutron diffraction studies of nerve myelin, 2:42021 (BNL-50453)
MYOBLASTS/CELL CULTURES
Development of the chick myoblast culture system for the study of toxicity of fly ash, 2:42121 (UCD-472-123)
MYOCARDIUM/BLOOD FLOW
Quantitation of ischemic and infarcted myocardium: relation between 99 Tc pyrophosphate and regional and total coronary blood flow, myocardial function and metabolism. Annual scientific report, 1 Jul 1975-31 Mar 1976, 2:42060 (PB-262160)
MYOCARDIUM/SCINTISCANNING
Quantitation of ischemic and infarcted myocardium: relation between 99 Tc pyrophosphate and regional and total coronary blood flow, myocardial function and metabolism. Annual scientific report, 1 Jul 1975-31 Mar 1976, 2:42060 (PB-262160)

N

NAPHTHA/CATALYTIC CRACKING
Catalytic reforming of hydrogenated shale-oil naphtha, 2:41054
Refining improvement of shale-oil naphtha, 2:41053
NAPHTHA/CHEMICAL ANALYSIS
Lead traces titration in naphthas, 2:41000
NAPHTHA/FRACTIONATION
Computer simulation of tower operation with two and three crude oil feed inlets, for partial topping of crude, 2:40942
NAPHTHA/MASS SPECTROSCOPY
Mass-spectrometric analysis of group composition of saturated petroleum hydrocarbons in crude oil, 2:40968
NAPHTHALENE/HYDROCRACKING
Hydrocracking of polynuclear aromatic hydrocarbons over silica-alumina based dual functional catalysts, 2:40953

NATURAL DRAFT COOLING TOWERS/DESIGN
Natural-draft cooling tower of the so-called dry type (Patent), 2:41252
NATURAL GAS
See also LIQUEFIED NATURAL GAS
NATURAL GAS/CHARGES
Economics of manufacturing synthesis gas produced by underground coal gasification, 2:40757 (MERC/SP-76/3)
NATURAL GAS/CHEMICAL COMPOSITION
Gas quality and geochemical studies in gas-stimulation experiments, 2:41040
NATURAL GAS/CHEMICAL RADIATION EFFECTS
Effects of heat and radiation on Gasbuggy chimney gas, 2:41039
NATURAL GAS/COMBUSTION PRODUCTS
Compilation of air pollutant emission factors. Supplement Number 6. Second edition, 2:41989 (PB-254274)
NATURAL GAS/COMBUSTION PROPERTIES
Process of combustion of a mixture of natural, coking, and blast-furnace gases in a reversible combined burner with controlled spray, 2:41031
NATURAL GAS/CONSUMPTION RATES
Monthly energy review, June 1976, 2:41601 (NTISUB/B-127-76/006)
NATURAL GAS/COST
Monthly energy review, June 1976, 2:41601 (NTISUB/B-127-76/006)
NATURAL GAS/DATA COMPILATION
Monthly energy review, 2:40911 (NTISUB/B-127-76/009)
NATURAL GAS/ECONOMICS
Two decades of natural gas, 2:41037
NATURAL GAS/ENERGY CONSERVATION
Consumption and conservation of natural gas. Highlight report, Volume XVIII. Monthly report, 2:41034 (PB-254629)
NATURAL GAS/ENHANCED RECOVERY
Chemistry of petroleum processing and extraction. III, 2:40938
NATURAL GAS/TERMINAL FACILITIES
Frigg onshore, 2:41043
NATURAL GAS/TRANSPORT
Deep water laying of steel pipe-lines using free fall technique, 2:41047
Experiences in using new steel types for high pressure gas lines constructing, 2:41044
Frigg onshore, 2:41043
International gas transmission, 2:41042
Natural gas pipeline through Lake Traun, 2:41046
Operational problems in gas piping system following conversion to natural gas, 2:41045
NATURAL GAS DEPOSITS/CALCULATION METHODS
Analysis of the reliability of the results of calculation of gas reserves by the volumetric method, 2:41032
NATURAL GAS DEPOSITS/EXPLORATION
Contemporary structure of the Lower permian sedimentary strata of the Dnieper-Donets depression, 2:40927
Method of determination of abnormally high formation pressures from the data of geophysical investigations of boreholes, 2:40926
New oil and gas exploration and prospecting directions in the Upper Pechora depression of the pre-Ural trough, 2:40925
Oil and gas from the North Sea. I, 2:40929
Paleogeomorphological preconditions of discovery of petroleum and gas-bearing zones in the Jurassic and Triassic complexes of Northern Emba, 2:40923
Phase state of hydrocarbons of the Caspian Depression, 2:40919
Prospects of discovering oil and gas deposits in the jurassic complexes of west siberia, 2:40922
U.s. geological survey's Project BIRDDOG (basic investigation of remotely detectable deposits of oil and gas), 2:40918
NATURAL GAS DEPOSITS/GEOCHEMICAL SURVEYS
Oil in the mouths of rivers, 2:40928 (N-76-27643)
NATURAL GAS DEPOSITS/GLOBAL ASPECTS
Petroleum and gas resources of foreign countries, 2:40916
NATURAL GAS DEPOSITS/PRODUCTION
Production statistics and engineering data: oil in North Dakota, second half 1976, 2:41647
NATURAL GAS DEPOSITS/SIMULATION
Our nation's crude oil and natural gas recoveries may be increased by numerical simulation, 2:40917
NATURAL GAS FIELDS/REVIEWS
List of Louisiana oil and gas fields and salt domes including the offshore areas showing code numbers and official abbreviations, 2:41646
NATURAL GAS INDUSTRY/ECONOMICS
Gas industry development in Federal Republic of Germany in 1975, 2:41036
NATURAL GAS INDUSTRY/ENERGY CONSUMPTION
Gas industry development in Federal Republic of Germany in 1975, 2:41036
NATURAL GAS INDUSTRY/OFFSHORE OPERATIONS
SEASAT economic assessment. Volume 3: offshore oil and natural gas industry case study and generalization. Final report, Feb 1974-Aug 1975, 2:40931 (N-76-28616)
NATURAL GAS INDUSTRY/PLANNING
Natural gas in the tenth five year plan in the USSR, 2:41038
NATURAL GAS INDUSTRY/TURBOMACHINERY
Possible use of expansion turbines in gas and petroleum industries, 2:40947
NATURAL GAS WELLS/HYDRAULIC FRACTURING
Successful stimulation of deep wells using high proppant concentrations, 2:40940
NEODYMIUM 142 TARGET/CARBON 13 REACTIONS
Nuclear and Coulomb deformation parameters in ^{142}Nd (67.5 MeV; angular distribution, DWBA analysis), 2:42205
NEODYMIUM LASERS/LASER MATERIALS
Evaluation of Nd:YVO_4 and Ho:Er:Tm:YVO_4 as pulse pumped q-switched lasers. Final report, 1 Jan 1974-1 Apr 1975, 2:41894 (AD-A-029916)
NEODYMIUM LASERS/MODULATION
1.06 micrometer wideband laser modulator: fabrication and life testing. Final report, 25 Jul 1974-25 Jul 1975, 2:41904 (N-76-27538)
NEODYMIUM LASERS/OPTICAL SYSTEMS
Array laser: a technique for the generation of ultra-high laser intensities, 2:41902 (LA-UR-75-2260)
Fast optics for the Rutherford laser compression experiments, 2:42307 (RL-76-147/B)
NEODYMIUM PERCHLORATES/OSMOSIS
Isopiestic determination of the activity coefficients of some aqueous rare earth electrolyte solutions at 25°C. II. The rare earth perchlorates, 2:41874
NEODYMIUM PERCHLORATES/THERMODYNAMIC PROPERTIES
Heats of dilution of some aqueous rare earth electrolyte solutions at 25°C. I. Rare earth perchlorates, 2:41873
NEON/THERMAL CONDUCTIVITY
Shock tube study of the coefficient of thermal conductivity of helium, neon, argon and krypton, 2:42229 (INIS-mf-3404)
NEON 20 REACTIONS/SPALLATION
Central collisions of relativistic heavy ions (250 to 2100-MeV/nucleon ^{20}Ne, 400-MeV/nucleon ^{4}He; light-particle energy spectra, differential cross sections), 2:42207
NEON ISOTOPES/COSMOCHEMISTRY
Cosmogenic radionuclides in stone meteorites, 2:42173 (N-76-25115)
NEOPLASMS
See also LYMPHOMAS
SARCOMAS
NEOPLASMS/RADIOINDUCTION
Clinical case load for radionuclide-treated beagles, calendar year 1975, 2:42088 (UCD-472-123)
Cumulative mortality in radionuclide treated beagles, 2:42089 (UCD-472-123)
Pathology in a lifespan study of x-irradiated adult female beagles, 2:42079 (UCD-472-123)
NEPTUNIUM
See also NEPTUNIUM-ALPHA
NEPTUNIUM/ELECTRONIC STRUCTURE
Localized vs itinerant 5f electrons: a review of the experimental evidence, 2:41769
NEPTUNIUM/LATTICE VIBRATIONS
Role of lattice vibrations in the determination of the physical properties of the actinides, 2:41773
NEPTUNIUM/MOESSBAUER EFFECT
Hyperfine interactions in Np Pdsub(3-x)Rhsub(x), 2:41770
NEPTUNIUM 237/MOESSBAUER EFFECT
Itinerant magnetism in $NpFe_2Si_2$ and $NpCo_2Si_2$, 2:41799
NEPTUNIUM ALLOYS
See also NEPTUNIUM BASE ALLOYS
NEPTUNIUM ALLOYS/ELECTRIC CONDUCTIVITY
Alloying, radiation damage, and Matthiessen's rule in plutonium, 2:41801
NEPTUNIUM ALLOYS/HYPERFINE STRUCTURE
Hyperfine interactions in Np Pdsub(3-x)Rhsub(x), 2:41770
NEPTUNIUM ALLOYS/MAGNETIZATION
Itinerant magnetism in $NpFe_2Si_2$ and $NpCo_2Si_2$, 2:41799
NEPTUNIUM ALLOYS/PHYSICAL RADIATION EFFECTS
Alloying, radiation damage, and Matthiessen's rule in plutonium, 2:41801
NEPTUNIUM BASE ALLOYS/SOLID SOLUTIONS
Splat cooling of some actinide alloys, 2:41760
NEPTUNIUM BASE ALLOYS/SPLAT COOLING
Splat cooling of some actinide alloys, 2:41760
NEPTUNIUM CARBIDES/ORDER PARAMETERS
Study of atomic short-range order in nonstoichiometric actinide carbides by diffuse neutron scattering, 2:41832

NEPTUNIUM COMPOUNDS/CRYSTAL-PHASE TRANSFORMATIONS
Some actinides double orthovanadates and orthoarsenates: structural 'evolution' due to cationic and anionic substitutions, 2:41779
NEPTUNIUM FLUORIDES/CRYSTAL FIELD
Ab initio calculations of the crystal field splittings for Np^{3+} centers in CaF_2 (as well as for selected other complexes) by molecular orbital techniques, 2:41823
NEPTUNIUM FLUORIDES/MOLECULAR ORBITAL METHOD
Ab initio calculations of the crystal field splittings for Np^{3+} centers in CaF_2 (as well as for selected other complexes) by molecular orbital techniques, 2:41823
NEPTUNIUM IONS/CRYSTAL FIELD
Ab initio calculations of the crystal field splittings for Np^{3+} centers in CaF_2 (as well as for selected other complexes) by molecular orbital techniques, 2:41823
NEPTUNIUM IONS/MOLECULAR ORBITAL METHOD
Ab initio calculations of the crystal field splittings for Np^{3+} centers in CaF_2 (as well as for selected other complexes) by molecular orbital techniques, 2:41823
NEPTUNIUM OXIDES/LATTICE PARAMETERS
Low temperature lattice parameters of the actinide dioxides, 2:41830
NEPTUNIUM-ALPHA/ELASTICITY
Mechanical properties of α-neptunium: hardness and elastic moduli, 2:41790
NEPTUNIUM-ALPHA/HARDNESS
Mechanical properties of α-neptunium: hardness and elastic moduli, 2:41790
NERVE CELLS/MOLECULAR BIOLOGY
Neutron diffraction studies of nerve myelin, 2:42021 (BNL-50453)
NET ENERGY
(Difference of energy output and energy input.)
Energy embodied in goods, 2:41654 (ORAU/IEA(M)-77-6)
Will the large-scale production of hydrogen be part of the energy problem or part of its solution, 2:41161
NETHERLANDS/RADIOACTIVE WASTE DISPOSAL
Review of Dutch geologic waste disposal programme, 2:41137 (IAEA-CN-36/289)
NEURONS
See NERVE CELLS
NEUTRAL BEAM SOURCES/ION BEAMS
Beam-plasma instability in ion beam systems used in neutral beam generation, 2:42279 (UCID-17404)
NEUTRAL BEAM SOURCES/PLASMA INSTABILITY
Beam-plasma instability in ion beam systems used in neutral beam generation, 2:42279 (UCID-17404)
NEUTRAL BEAM SOURCES/RESEARCH PROGRAMS
Neutral beam injector research and development work in the USA, 2:42302 (BNL-22436)
NEUTRON DIFFUSION EQUATION/FINITE DIFFERENCE METHOD
Coarse-mesh correction of the finite difference method for neutron diffusion calculations (LMFBR), 2:41416
NEUTRON DIFFUSION EQUATION/ITERATIVE METHODS
Groupwise rebalancing technique for integral transport problems, 2:41462
NEUTRON EMISSION/NEUTRON REACTIONS
Calculations of the neutron emission spectra from materials bombarded with 14-mev neutrons, 2:42290
NEUTRON REACTIONS/CAPTURE
Average neutron resonance parameters and radiative capture cross sections for the isotopes of molybdenum (3 to 90 keV), 2:42204
Study of the $^{238}U(n,\gamma)^{239}U$ reaction, 2:42206 (INIS-mf-3352)
NEUTRON REACTIONS/CROSS SECTIONS
Neutron absorption cross section of sodium 22 (Westcott procedure), 2:42201
NEUTRON REACTIONS/MEASURING METHODS
Californium-252 fission spectrum irradiation facility for neutron reaction rate measurements, 2:41154
NEUTRON REACTIONS/PICKUP REACTIONS
Cross section for the $^{9}Be(n,t_1)^{7}Li$ reaction between 13.3 and 15 MeV, 2:42200
NEUTRON REFLECTORS/DESIGN
Representation of the light-water reflectors by boundary conditions (PWR), 2:41340
NEUTRON SOURCES
(Excludes reactors even when used as neutron sources.)
NEUTRON SOURCES/DESIGN
Californium-252 fission spectrum irradiation facility for neutron reaction rate measurements, 2:41154
NEVADA/GEOLOGY
Summary of space imagery studies in Utah and Nevada, 2:42142 (E-76-10420)
NEVADA/REMOTE SENSING
Summary of space imagery studies in Utah and Nevada, 2:42142 (E-76-10420)
NEW MEXICO/METEOROLOGY
Compilation of solar data for White Sands Missile Range, 2:41232 (AD-A-029155)
NICKEL/ABSORPTION SPECTROSCOPY
Evaluation of a carbon-rod atomizer for routine determination of trace metals by atomic-absorption spectroscopy. Applications to analysis of lubricating oil and crude oil, 2:41016
Novel wet-digestion procedure for trace-metal analysis of coal by atomic absorption, 2:40836
NICKEL/CATALYTIC EFFECTS
Mass-spectrometric measurements of enhanced methanation activity over cobalt and nickel foils. Interim report, 2:41170 (AD-A-034675)
NICKEL/COATINGS
Electrodeposition of titanium diboride coatings. Report of investigations 1976, 2:41816 (PB-257 384)
NICKEL/ENVIRONMENTAL TRANSPORT
Trace element geochemistry of the South Atlantic Bight. Progress report, June 1, 1976-May 31, 1977, 2:42147 (SRO-890-2)
NICKEL/NEUTRON REACTIONS
Calculations of the neutron emission spectra from materials bombarded with 14-mev neutrons, 2:42290
NICKEL 58 TARGET/ALPHA REACTIONS
Energy dependence of the optical model parameters for α-particles scattered from ^{40}Ca and ^{58}Ni (< 85.6 MeV; differential cross sections), 2:42202
NICKEL ALLOYS
See also NICKEL STEELS
NICKEL ALLOYS/COATINGS
Coatings for directional eutectics. Final report (NiCrAlCy coating for NiTaC-13), 2:41814 (N-76-29370)
NICKEL ALLOYS/FRACTURE PROPERTIES
Nonlinear compliance curves caused by crack closure in fracture tests of tungsten alloy, 2:41786
NICKEL ALLOYS/MECHANICAL PROPERTIES
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)
NICKEL ALLOYS/OXIDATION
Coatings for directional eutectics. Final report (NiCrAlCy coating for NiTaC-13), 2:41814 (N-76-29370)
NICKEL ALLOYS/SORPTIVE PROPERTIES
Investigation of metal hydride materials as hydrogen reservoirs for metal-hydrogen batteries, 2:41162 (N-76-27667)
NICKEL ALLOYS/THERMAL CONDUCTIVITY
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)
NICKEL ALLOYS/VACUUM COATING
Coatings for directional eutectics. Final report (NiCrAlCy coating for NiTaC-13), 2:41814 (N-76-29370)
NICKEL CHLORIDES/TOXICITY
Aminoaciduria and proteinuria in rats after a single intraperitoneal injection of Ni(II), 2:42126
NICKEL COMPOUNDS/BIOLOGICAL EFFECTS
Review of the carcinogenicities of nickel, chromium, and arsenic compounds in man and animals, 2:42132
NICKEL STEELS
(Steels containing only nickel as alloying element.)
NICKEL STEELS/MECHANICAL PROPERTIES
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)
NICKEL STEELS/TESTING
Automatic welding for an LNG storage tank of 9% nickel steel, 2:41049
NICKEL STEELS/THERMAL CONDUCTIVITY
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)
NICKEL-CADMIUM BATTERIES/ANODES
Cadmium migration in aerospace nickel cadmium cells, 2:41571 (N-76-24703)
NICKEL-CADMIUM BATTERIES/COVERINGS
Hermetic covers for European Ni/Cd cells, 2:41575 (N-76-27697)
NICKEL-CADMIUM BATTERIES/ELECTROCHEMISTRY
Cadmium migration in aerospace nickel cadmium cells, 2:41571 (N-76-24703)
NICKEL-ZINC BATTERIES/CATHODES
Development and fabrication of large vented nickel-zinc cells. Final report (300 Ah), 2:41568 (N-76-28642)
NICKEL-ZINC BATTERIES/DESIGN
Development and fabrication of large vented nickel-zinc cells. Final report (300 Ah), 2:41568 (N-76-28642)
NIGHTGLOW
See AIRGLOW
NIOBIUM/METALLURGICAL EFFECTS
Metallurgical factors controlling weld metal toughness in the seam welding of line pipe, 2:41758 (PB-256057)
NIOBIUM/NEUTRON REACTIONS
Calculations of the neutron emission spectra from materials bombarded with 14-mev neutrons, 2:42290

DT fusion neutron irradiation of LLL "tritium-tricked" niobium, BNL-LASL superconductor wires, BPNL wire-foil packages, 2:42320 (UCID-17431)

NIOBIUM/PHONONS
Phonon anomalies in transition metals, alloys, and compounds, 2:41809

NIOBIUM/PHYSICAL RADIATION EFFECTS
Fusion power program. Quarterly progress report, October-December 1976, 2:42314 (ANL/FPP-76-6)

NIOBIUM/SUPERCONDUCTIVITY
Phonon anomalies in transition metals, alloys, and compounds, 2:41809

NIOBIUM/TRANSITION TEMPERATURE
Gas anisotropy and T/sub c/ enhancement: general theory, and calculations for Nb, using Fermi surface harmonics, 2:41810

NIOBIUM ALLOYS
See also INCONEL 600
INCONEL 718

NIOBIUM ALLOYS/CRYSTAL-PHASE TRANSFORMATIONS
Shear martensitic transformation in uranium alloys during quenching, plastic deformation and low temperature annealing, 2:41776

NIOBIUM ALLOYS/MECHANICAL PROPERTIES
Semi-annual report on materials research in support of superconducting machinery. Final report (Composite materials), 2:41784 (PB-261996)

NIOBIUM ALLOYS/THERMAL CONDUCTIVITY
Semi-annual report on materials research in support of superconducting machinery. Final report (Composite materials), 2:41784 (PB-261996)

NIOBIUM ALLOYS/THERMOELECTRIC PROPERTIES
Thermoelectric properties of solid solutions based on uranium and thorium, 2:41805

NITRATES/AEROSOL MONITORING
Gas chromatographic analysis of air pollutants, 2:41985

NITRATES/DENITRIFICATION
Nitrogen isotope discrimination in denitrification of nitrate in soils, 2:41995

NITRATES/LABELLING
Synthesis of ^{13}N- and ^{38}S-labeled fossil fuel power plant effluents for in vivo distribution studies, 2:42125 (UCD-472-123)

NITRATES/MONITORING
National air sampling network. Status report, 2:41966 (PB-255288)

NITRATES/SOIL CHEMISTRY
Nitrogen isotope discrimination in denitrification of nitrate in soils, 2:41995

NITRATES/SPECTROSCOPY
Laser Raman spectrometric determination of oxy-anions in nuclear waste materials, 2:41868 (ARH-SA-279)

NITRITES/SPECTROSCOPY
Laser Raman spectrometric determination of oxy-anions in nuclear waste materials, 2:41868 (ARH-SA-279)

NITROGEN/ACTIVATION ANALYSIS
Application of Bremsstrahlung activation analysis to the determination of carbon and nitrogen in sodium, 2:41865 (CEA-CONF-3657)

NITROGEN/CHEMICAL REACTION YIELD
Studies of the emission of elemental nitrogen from coals of different rank and its release under geochemical conditions, 2:40846

NITROGEN/CHEMICAL REACTIONS
Reactions of coal with nitrogen/hydrogen mixtures in a discharge, 2:40844
Reactions of coal with discharge-generated (excited) nitrogen species, 2:40845

NITROGEN/CHEMILUMINESCENCE
Cn production efficiencies from active nitrogen-hydrocarbon flames. Interim report, 2:41167 (AD-A-026638)

NITROGEN/FLAMES
Cn production efficiencies from active nitrogen-hydrocarbon flames. Interim report, 2:41167 (AD-A-026638)

NITROGEN/FLOW RATE
Prandtl-Meyer flow tables for parahydrogen at total temperatures from 30°K to 290°K and for nitrogen at total temperatures from 100°K to 300°K at total pressures from 1 atm to 10 atm, 2:41164 (N-76-30497)

NITROGEN/MACH NUMBER
Prandtl-Meyer flow tables for parahydrogen at total temperatures from 30°K to 290°K and for nitrogen at total temperatures from 100°K to 300°K at total pressures from 1 atm to 10 atm, 2:41164 (N-76-30497)

NITROGEN/REMOVAL
New concept for in situ coal gasification, 2:40791
Studies of the emission of elemental nitrogen from coals of different rank and its release under geochemical conditions, 2:40846

NITROGEN/VOLTAMETRY
Microcoulometric determination of sulphur at sub-ppm levels using the standby technique, 2:41020

NITROGEN 13/LABELLED COMPOUNDS
Synthesis of ^{13}N- and ^{38}S-labeled fossil fuel power plant effluents for in vivo distribution studies, 2:42125 (UCD-472-123)

NITROGEN 15/NUCLEAR MAGNETIC RESONANCE
Nuclear magnetic resonance of carbon 13 and nitrogen 15 in uranium and thorium carbonitrides, 2:41824

NITROGEN DIOXIDE/CHEMICAL REACTIONS
Determination of absolute photon yields in chemiluminescent reactions. Annual technical report, 3 Dec 1975-2 Dec 1976, 2:41872 (AD-A-034515)

NITROGEN OXIDES
See also NITROGEN DIOXIDE
NITROUS OXIDE

NITROGEN OXIDES/INHALATION
Secondary aerosols from power plant effluents: delivery and in vivo detection systems (Tissue distribution of inhaled radioisotope-labelled $(NH_4)_2SO_4$ and NH_4NO_3 aerosols in monkeys), 2:42124 (UCD-472-123)

NITROGEN OXIDES/MONITORING
National air sampling network. Status report, 2:41966 (PB-255288)

NITROGEN OXIDES/OXIDATION
Technology and economics of flue gas NO/sub x/ oxidation by ozone. Final report, Jul-Oct 1976, 2:41975 (PB-261917)

NITROGEN OXIDES/SAMPLING
Regional air pollution study: quality assurance audits. Final report, 2:41967 (PB-255313)

NITROGEN OXIDES/STANDARDS
Guideline for public reporting of daily air quality: Pollutant Standards Index (PSI). Final report, 2:41992 (PB-257892)

NITROGEN OXIDES/TISSUE DISTRIBUTION
Secondary aerosols from power plant effluents: delivery and in vivo detection systems (Tissue distribution of inhaled radioisotope-labelled $(NH_4)_2SO_4$ and NH_4NO_3 aerosols in monkeys), 2:42124 (UCD-472-123)

NITROUS OXIDE/CHEMICAL REACTIONS
Determination of absolute photon yields in chemiluminescent reactions. Annual technical report, 3 Dec 1975-2 Dec 1976, 2:41872 (AD-A-034515)

NOCTILUCENT CLOUDS
Optical observations from the Voskhod-2 spacecraft, 2:42172 (N-76-28122)

NOISE POLLUTION/BIOLOGICAL EFFECTS
Hearing conservation program prototype phase final report. Technical report, 2:42136 (AD-A-030896)

NORTH CAROLINA/AIR QUALITY
North Carolina air quality maintenance area analysis. Volume I. TSP area source emission inventories for Charlotte, Winston-Salem, and Greensboro AQMA's for 1973, 1975, 1980, and 1985. Final report, 2:41991 (PB-255218)

NORTH CAROLINA/ENERGY POLICY
"North Carolina Energy Policy Council" Annual report. Volume I, 2:41636
"North Carolina Energy Policy Council" Annual report. Volume II, 2:41637

NORTH DAKOTA/ENERGY SUPPLIES
Crude supply alternatives for the northern tier states. Volume I. Executive summary, 2:41643 (PB-255992)
Crude supply alternatives for the northern tier states. Volume II. Technical report, 2:41644 (PB-255993)

NORTH DAKOTA/NATURAL GAS DEPOSITS
Production statistics and engineering data: oil in North Dakota, second half 1976, 2:41647

NORTH DAKOTA/PETROLEUM DEPOSITS
Production statistics and engineering data: oil in North Dakota, second half 1976, 2:41647

NORTH SEA/NATURAL GAS DEPOSITS
Oil and gas from the North Sea. I, 2:40929

NORTH SEA/OFFSHORE PLATFORMS
Materials and welding related to the construction of fixed offshore installations, 2:40936

NORTH SEA/PETROLEUM DEPOSITS
Oil and gas from the North Sea. I, 2:40929

NORTHERN IRELAND
See UNITED KINGDOM

NORTHERN STATES MONTICELLO REACTOR
See MONTICELLO REACTOR

NPR REACTOR
See N-REACTOR

N-REACTOR/FUEL ELEMENTS
Braze ring qualification program, 2:41506 (UNI-187(Rev.1))

NUCLEAR EXPLOSION DETECTION/SEISMIC DETECTION
Vela network evaluation and automatic processing research. Quarterly report No. 5, 10 Jul-10 Oct 1976, 2:41946 (AD-A-034769)

NUCLEAR EXPLOSIONS
See also GASBUGGY EVENT
RULISON EVENT

NUCLEAR EXPLOSIONS/DATA ANALYSIS
Ready I system for the UNIVAC 1108 summary analysis program, 2:41945 (PB-257702)
NUCLEAR EXPLOSIONS/NUCLEAR EXPLOSION DETECTION
Applications of higher mode surface waves. Technical report, 2:41947 (AD-A-034883)
Network capability estimation. Vela network evaluation and automatic processing research. Technical report, 2:41948 (AD-A-034897)
NUCLEAR EXPLOSIONS/SHOCK WAVES
NOVA-2: a digital computer program for analyzing nuclear overpressure effects on aircraft. Part 2. Computer program. Final report, 2:41943 (AD-A-029389)
NUCLEAR INDUSTRY
Experience in the manufacture of nuclear equipment in India, 2:41307 (IAEA-CN-36/462)
NUCLEAR INDUSTRY/PLANNING
Directors' report, 1975 (German Federal Republic), 2:41352 (DEU-76-38)
NUCLEAR MATERIALS DIVERSION/ACCOUNTING
New approach to safeguards accounting (Kalman filter method for detecting continual small losses), 2:41145 (ORNL/CSD/TM-25)
NUCLEAR PARKS/GOVERNMENT POLICIES
Nontechnical issues associated with LMFBR energy centers, 2:41604 (ORAU/IEA(M)-76-15)
NUCLEAR PARKS/SOCIO-ECONOMIC FACTORS
Nontechnical issues associated with LMFBR energy centers, 2:41604 (ORAU/IEA(M)-76-15)
NUCLEAR POWER
Italian nuclear activities in 1974, 2:41311
NUCLEAR POWER/ECONOMICS
Consequences of the energy crisis, 2:41631
Research programs in nuclear technology (Czechoslovakia), 2:41439 (INIS-mf-3391)
NUCLEAR POWER/FORECASTING
European Community care for nuclear power, 2:41304 (IAEA-CN-36/365)
NUCLEAR POWER/PLANNING
Advisability of nuclear energy: analysis from the point of view of the electric generating system (Portugal), 2:41441
Co-operation of the CMEA member countries in the developing power reactors of various types, including some aspects of their nuclear fuel cycles, 2:41301 (IAEA-CN-36/6)
Contribution of nuclear energy to the meeting of Italy's electric power requirements, 2:41308 (IAEA-CN-36/464)
India's nuclear power programme and constraints encountered in its implementation, 2:41369 (IAEA-CN-36/385)
Plutonium utilization in thermal and fast reactor in Japan, 2:41303 (IAEA-CN-36/162)
South Africa's nuclear energy analysis, 2:41442
Structure of atomic power industry with allowance for energy production other than electricity, 2:41438 (IAEA-CN-36/337)
UK experience of planning the nuclear contribution to the UK power programme, 2:41302 (IAEA-CN-36/53)
NUCLEAR POWER/PUBLIC RELATIONS
Energy policy and public acceptance (Sweden), 2:41493 (IAEA-CN-36/588)
NUCLEAR POWER PLANTS/COMPARATIVE EVALUATIONS
Nuclear power plants: an alternative for large cities, 2:41443
NUCLEAR POWER PLANTS/CONDENSER COOLING SYSTEMS
Simulation of spray canal cooling for power plants--performance and environmental effects, 2:41484
NUCLEAR POWER PLANTS/CONSTRUCTION
Changes in an electric utility's fuel base, 2:41653
New nuclear power plants in the German Federal Republic. Part 1 of a report on nuclear power plant projects in Europe, 2:41300 (CS-INIS-26)
NUCLEAR POWER PLANTS/CONTAINMENT BUILDINGS
Testing of coatings for the nuclear industry, 2:41466 (CONF-770301-12)
NUCLEAR POWER PLANTS/CONTAINMENT SYSTEMS
Trends in the development of reactor containments, 2:41469 (IAEA-CN-36/306)
NUCLEAR POWER PLANTS/COOLING TOWERS
Environmental impact assessment of cooling towers, 2:41499
NUCLEAR POWER PLANTS/COST
Monte Carlo error analysis of power plant capital cost calculations, 2:41440 (K/CSD-3)
NUCLEAR POWER PLANTS/DISTRICT HEATING
Use of nuclear reactors for central heat supply and district heating, 2:41449 (IAEA-CN-36/338)
NUCLEAR POWER PLANTS/ENVIRONMENTAL EFFECTS
PREPR2: a program to aid in the preparation of input data for the farout hydraulic transport code, 2:41495 (ORNL/CSD/TM-19)
NUCLEAR POWER PLANTS/ENVIRONMENTAL IMPACTS
Evaluation of nuclear power plant environmental impact prediction, based on monitoring programs. Summary and recommendations, 2:41492 (BNWL-2153)
NUCLEAR POWER PLANTS/FUEL MANAGEMENT
Simulation methods for nuclear production scheduling, 2:41446
NUCLEAR POWER PLANTS/HEAT EXCHANGERS
Corrosion in condensers and coolers of nuclear power due to cooling water, 2:41813 (EBO-P-673)
NUCLEAR POWER PLANTS/IN-SERVICE INSPECTION
Experience focuses attention on details of in-service inspection in nuclear plants, 2:41481
NUCLEAR POWER PLANTS/INSPECTION
Monthly inspection summary report, 2:41433 (NTISUB/B-124-76/010)
NUCLEAR POWER PLANTS/LIQUID-METAL MHD GENERATORS
Electrical engineering characteristics of MHD generators operating by emulsion, 2:41661
NUCLEAR POWER PLANTS/MISSILE PROTECTION
Tornado missile risk analysis. Topical report No. 1, 2:41535 (PB-254415)
NUCLEAR POWER PLANTS/OPERATION
Monthly energy review, June 1976, 2:41601 (NTISUB/B-127-76/006)
NUCLEAR POWER PLANTS/PERSONNEL
Indian experience in the training of manpower for nuclear power programme, 2:41306 (IAEA-CN-36/459)
NUCLEAR POWER PLANTS/PLANNING
Arguments for the installation of small LWR nuclear power plants in developing countries, 2:41315 (IAEA-CN-36/89)
Development of the national nuclear programme and preparations for the introduction of nuclear power in Hungary, 2:41305 (IAEA-CN-36/420)
Main ways of nuclear power development (Czechoslovakia), 2:41310 (INIS-mf-3391)
NUCLEAR POWER PLANTS/POWER GENERATION
Changes in an electric utility's fuel base, 2:41653
NUCLEAR POWER PLANTS/RADIOACTIVE WASTE DISPOSAL
Discharge into the atmosphere of volatile fission products from nuclear power stations and fuel reprocessing plants and the perspectives of their retention, 2:41132 (IAEA-CN-36/317)
NUCLEAR POWER PLANTS/RADIOACTIVE WASTE MANAGEMENT
Handling of waste at Swedish nuclear power plants, 2:41121 (IAEA-CN-36/282)
NUCLEAR POWER PLANTS/REACTOR LICENSING
Licensee contractor and vendor inspection status report. Quarterly report, 2:41435 (PB-255418)
NUCLEAR POWER PLANTS/REACTOR OPERATION
Recent U.S. reactor operating experience, 2:41309 (IAEA-CN-36/483)
NUCLEAR POWER PLANTS/REACTOR PROTECTION SYSTEMS
Common mode failure analysis, 2:41539
NUCLEAR POWER PLANTS/SAFETY ENGINEERING
Status for seismic design requirements of nuclear power plants in Japan, 2:41517 (IAEA-CN-36/159)
NUCLEAR POWER PLANTS/SEISMIC EFFECTS
Matrix exponential approach to dynamic response, 2:41542
Probabilistic and statistical models for seismic risk analysis, 2:41537 (PB-259188)
Status for seismic design requirements of nuclear power plants in Japan, 2:41517 (IAEA-CN-36/159)
NUCLEAR POWER PLANTS/SITE SELECTION
Economics of power plant siting in southeastern New England. Final report, 2:41283 (PB-254743)
Maryland Power Plant Siting Project: an application of the ORNL-Land Use Screening Procedure, 2:41496 (ORNL/NUREG/TM-79)
PREPR2: a program to aid in the preparation of input data for the farout hydraulic transport code, 2:41495 (ORNL/CSD/TM-19)
NUCLEAR POWER PLANTS/STEAM CONDENSERS
Corrosion in condensers and coolers of nuclear power due to cooling water, 2:41813 (EBO-P-673)
NUCLEAR POWER PLANTS/STEAM GENERATORS
Element-type steam generators inspection with regard to operating reliability, 2:41471 (INIS-mf-3389)
Thermal mechanical analysis procedure for a semicircular plate with clamped straight edge (U-tube steam generator divider plate), 2:41474
NUCLEAR POWER PLANTS/THERMAL EFFLUENTS
Stratified flows produced upon discharge of hot power-plant effluents into cooling ponds and rivers, 2:41498
NUCLEAR REACTORS
See REACTORS

NUCLEAR SHIPS/ACCIDENTS
Ship collision study. Present situation survey. Final report, Jul 1974-Oct 1975, 2:41508 (PB-254750)
NUCLEAR SHIPS/PLANNING
Nuclear merchant ship propulsion, 2:41507 (IAEA-CN-36/93)
NUCLEAR SUPERHEATING/EFFICIENCY
Nuclear steam superheat results and current prospects, 2:41358 (IAEA-CN-36/325)
NUCLEAR WEAPON TESTS
See NUCLEAR EXPLOSIONS
NUCLEAR WEAPONS/DESIGN
AFWL Technical Objective Number 4, nuclear systems support. FY 1978. Final report, Jan 1977-Jan 1978, 2:41944 (AD-A-034399)
NUCLEAR WEAPONS/SAFETY
AFWL Technical Objective Number 4, nuclear systems support. FY 1978. Final report, Jan 1977-Jan 1978, 2:41944 (AD-A-034399)
NUCLEI
See also LIGHT NUCLEI
NUCLEI/ENERGY LEVELS
Comprehensive formalism for the analysis of recoil-distance lifetimes, 2:42198
NUCLEOTIDES/MOLECULAR STRUCTURE
Nucleotide sequence of a viral RNA fragment that binds to eukaryotic ribosomes, 2:42032

O

OAK RIDGE RESEARCH REACTOR
See ORR REACTOR
OBRIGHEIM REACTOR/FUEL ELEMENTS
Comparison of the power distribution in uranium and plutonium fuel elements in the KWO core, 2:41485
OBRIGHEIM REACTOR/POWER DISTRIBUTION
Comparison of the power distribution in uranium and plutonium fuel elements in the KWO core, 2:41485
OCCUPATIONAL DISEASES
Review of the carcinogenicities of nickel, chromium, and arsenic compounds in man and animals, 2:42132
OCEANS
See SEAS
ODOR/AEROSOL MONITORING
Gas chromatographic analysis of air pollutants, 2:41985
OECD
(Organization of Economic Co-operation and Development.)
OECD/RADIOACTIVE WASTE MANAGEMENT
Present trends in radioactive waste management policies in OECD countries and related international co-operative efforts, 2:41126 (IAEA-CN-36/491)
OFF-GAS SYSTEMS/RELIABILITY
Nuclear off-gas treatment...the cryogenic distillation method (BWR), 2:41323
OFFICE BUILDINGS/ENERGY CONSUMPTION
Study of earth-covered buildings by an electric utility company, 2:41613 (NSF-RA-760006)
OFFICE BUILDINGS/SOLAR AIR CONDITIONING
Analysis of solar energy system for the GSA demonstration office building at Manchester, New Hampshire. Final report, 2:41211 (PB-254179)
OFFICE BUILDINGS/SOLAR SPACE HEATING
Analysis of solar energy system for the GSA demonstration office building at Manchester, New Hampshire. Final report, 2:41211 (PB-254179)
OFFICE BUILDINGS/UNDERGROUND
Study of earth-covered buildings by an electric utility company, 2:41613 (NSF-RA-760006)
OFF-PEAK ENERGY STORAGE/LITHIUM-SULFUR BATTERIES
High-performance batteries for off-peak energy storage and electric-vehicle propulsion. Progress report for the period July-September 1976 (Li-Al/Kcl-LiCl/Fes or FeS_2; tests of Li/TiS_2, Na/FeS_2, and $CaMg_2$/FeS cells), 2:41567 (ANL-76-98)
Metallic sulfide additives for positive electrode material within a secondary electrochemical cell (Patent; Fe sulfide electrode with sulfide additives of Co, Ni, Cu, Ce, Mn), 2:41577
OFF-PEAK ENERGY STORAGE/SODIUM-SULFUR BATTERIES
Anodic evolution of sulphur from sodium polysulphide melts. I. Voltammetric measurements on planar carbon electrodes, 2:41573
Metallic sulfide additives for positive electrode material within a secondary electrochemical cell (Patent; Fe sulfide electrode with sulfide additives of Co, Ni, Cu, Ce, Mn), 2:41577
OFF-PEAK POWER/ECONOMICS
Assessing the potential for optimal utilization of off-peak power. Volume II. Electrical loads offering major potential for the use of off-peak power. Final report, 2:41651 (PB-254775)
OFF-PEAK POWER/USES
Assessing the potential for optimal utilization of off-peak power. Volume I. Executive summary. Final report, 2:41650 (PB-254774)
Assessing the potential for optimal utilization of off-peak power. Volume II. Electrical loads offering major potential for the use of off-peak power. Final report, 2:41651 (PB-254775)
OFFSHORE NUCLEAR POWER PLANTS/FIRE PREVENTION
Exposure fire protection for floating nuclear power plants, 2:41543
OFFSHORE PLATFORMS/CONSTRUCTION
Design, material and production - a complex problem within shipbuilding, 2:40935
Materials and welding related to the construction of fixed offshore installations, 2:40936
Offshore platform (Patent), 2:41890
OFFSHORE PLATFORMS/DESIGN
Design, material and production - a complex problem within shipbuilding, 2:40935
OFFSHORE PLATFORMS/MAINTENANCE
Materials and welding related to the construction of fixed offshore installations, 2:40936
OFFSHORE PLATFORMS/MATERIALS
Materials and welding related to the construction of fixed offshore installations, 2:40936
OFFSHORE PLATFORMS/WELDING
Materials and welding related to the construction of fixed offshore installations, 2:40936
OFFSHORE SITES/PIPELINES
Model testing techniques in offshore pipelining, 2:40997
OHIO/COAL GASIFICATION PLANTS
Coal gasification in southeastern Ohio: water supply and demand. Completion report, 2:40789 (PB-254836)
OIL FIELDS
Carbon dioxide sources and oilfields in a nine-state area of the southwest United States, 2:40930 (BERC/IC-77/1)
OIL FIELDS/GEOLOGIC FAULTS
Recent surface movements in the Baldwin Hills, Los Angeles County, California, 2:40937
OIL FIELDS/GROUND SUBSIDENCE
Recent surface movements in the Baldwin Hills, Los Angeles County, California, 2:40937
OIL FIELDS/REVIEWS
List of Louisiana oil and gas fields and salt domes including the offshore areas showing code numbers and official abbreviations, 2:41646
OIL FIELDS/TECTONICS
Recent surface movements in the Baldwin Hills, Los Angeles County, California, 2:40937
OIL SANDS/COMPARATIVE EVALUATIONS
Bitumen recovery from oil sands, using solvents in conjunction with steam, 2:41050
OIL SANDS/IN-SITU PROCESSING
In Situ Hydrocarbon Recovery Simulation Laboratory research at Morgantown Energy Research Center, 2:40779 (MERC/SP-76/3)
OIL SANDS/MISCIBLE-PHASE DISPLACEMENT
Asphaltene flocculation during solvent stimulation of heavy oils, 2:40941
OIL SANDS/PERFORMANCE
Bitumen recovery from oil sands, using solvents in conjunction with steam, 2:41050
OIL SANDS/PROCESSING
Conversion of Athabasca bitumen, 2:41052
OIL SHALES/BY-PRODUCTS
Pilot plant for producing a mixture of crude dicarboxylic acids from shale, 2:41067 (PB-254581-T/SL)
OIL SHALES/CHEMICAL COMPOSITION
Investigation of the group and component composition of the alcohol-benzene extract of the combustible shale of the boltysh deposit of the Ukrainian SSR, 2:41065
OIL SHALES/IN-SITU PROCESSING
In Situ Hydrocarbon Recovery Simulation Laboratory research at Morgantown Energy Research Center, 2:40779 (MERC/SP-76/3)
OIL SHALES/IN-SITU RETORTING
Engineering aspects of processing oil shale by in situ retorting, 2:41051
OIL SHALES/POROSITY
Porous structure and specific surface of combustible shale, 2:41066
OIL SHALES/RETORTING
Alternative liquid fuels and the ERDA program, 2:41639
Chemistry of petroleum processing and extraction. II, 2:40949
Field compaction tests. Research and development program on the disposal of retorted oil shale-Paraho Oil Shale Project. Open file report, 2:41068 (PB-254728)

OIL SHALES/SURFACE PROPERTIES
Porous structure and specific surface of combustible shale, 2:41066
OIL SPILLS/ACTIVATION ANALYSIS
Mode of occurrence of trace elements in petroleum and relationship to oil-spill identification methods, 2:41027
OIL SPILLS/BIBLIOGRAPHIES
Spreading, retention and clean-up of oil spills. Final report, 2:40985 (COO-2756-1)
OIL SPILLS/BIODEGRADATION
Biodeterioration of oil spills (a bibliography with abstracts). Report for 1964-Jan 1977, 2:42008 (NTIS/PS-77/0046)
Spreading, retention and clean-up of oil spills. Final report, 2:40985 (COO-2756-1)
OIL SPILLS/BIOLOGICAL EFFECTS
Environmental effects of Schuylkill oil spill II, June 1972, 2:40989 (PB-258412)
OIL SPILLS/CLASSIFICATION
Characterization and identification of spilled residual fuel oils by gas chromatography and infrared spectrophotmetry, 2:40993
Characterization of heavy residual fuel oils and asphalts by infrared spectrophotometry using statistical discriminant function analysis, 2:40994
OIL SPILLS/CONTAINMENT
Spreading, retention and clean-up of oil spills. Final report, 2:40985 (COO-2756-1)
OIL SPILLS/ENVIRONMENTAL EFFECTS
The interrelationship of material toxicity, stream properties and quantity of spilled material in assessing the risk of hazardous material spills, 2:40991 (PB-259098)
Tomano oil spill in Casco Bay: environmental effects and cleanup operations, 2:40988 (PB-257950)
OIL SPILLS/ORIGIN
Feature extraction techniques for classification and identification of spectral signatures. Technical report, 2:40982 (AD-A-027848)
OIL SPILLS/QUALITATIVE CHEMICAL ANALYSIS
Identifying source of petroleum by infrared spectroscopy, 2:40992
OIL SPILLS/QUANTITATIVE CHEMICAL ANALYSIS
Shipboard oil-in-water monitor. Final report 24 May 74-30 Jun 76, 2:40983 (AD-A-028785)
OIL SPILLS/REMOVAL
Controllable sorbent broadcaster, 2:40984 (AD-D-003269)
Tomano oil spill in Casco Bay: environmental effects and cleanup operations, 2:40988 (PB-257950)
OIL SPILLS/REVIEWS
Baseline study program, North Puget Sound. Biological oil impact literature review. Volume I. Text. Final report, 2:40987 (PB-254291)
OIL SPILLS/SAMPLING
Shipboard oil-in-water monitor. Final report 24 May 74-30 Jun 76, 2:40983 (AD-A-028785)
OIL SPILLS/STATISTICS
Spreading, retention and clean-up of oil spills. Final report, 2:40985 (COO-2756-1)
OIL WELLS
See also PETROLEUM
OIL WELLS/ACIDIZATION
Analysis of the acidizing process in acid fracturing, 2:40939
OIL WELLS/HYDRAULIC FRACTURING
Successful stimulation of deep wells using high proppant concentrations, 2:40940
OIL WELLS/MISCIBLE-PHASE DISPLACEMENT
Asphaltene flocculation during solvent stimulation of heavy oils, 2:40941
OIL WELLS/WELL STIMULATION
The potential and economics of enhanced oil recovery. Final report, 2:40932 (PB-254991)
OIL-FILLED CABLES/DESIGN
380 kV single-core oil-filled cables and fittings, 2:41295
OLEFINS
See ALKENES
OLIGONUCLEOTIDES
See NUCLEOTIDES
ONCOGENIC VIRUSES/BIOLOGICAL EFFECTS
Study of Rous sarcoma virus-transformed baby hamster kidney cells using fluorescent probes, 2:42037
ON-LINE CONTROL SYSTEMS
Computer-based transportable data-acquisition and control system, 2:41938 (UCRL-78339(Rev.1))
ONTARIO PHWR PICKERING-1 REACTOR
See PICKERING-1 REACTOR
ONTARIO PHWR PICKERING-2 REACTOR
See PICKERING-2 REACTOR
ONTARIO PHWR PICKERING-3 REACTOR
See PICKERING-3 REACTOR
ONTARIO PHWR PICKERING-4 REACTOR
See PICKERING-4 REACTOR
OPTICAL EQUIPMENT/SERVICE LIFE
1.06 micrometer wideband laser modulator: fabrication and life testing. Final report, 25 Jul 1974-25 Jul 1975, 2:41904 (N-76-27538)
OPTIMIZATION/RESEARCH PROGRAMS
Extension of quasi-Newton methods to constrained optimization and to general systems of nonlinear equations and inequalities. Progress report, February 1, 1976-January 31, 1977 (Rice Univ.), 2:42328 (ORO-5046-1)
Systems Optimization Project. Progress report, 1 October 1975-30 June 1976 (Systems Optimization Lab., Dept. of Operations Research, Stanford Univ.), 2:42331 (SU-326P18X10)
OREGON/WATER QUALITY
Environmental quality profile, 1976. Alaska, Oregon, Idaho, Washington. Final report, 2:41990 (PB-255101)
ORGANIC COMPOUNDS
See also AMINES
CHEMICAL FEEDSTOCKS
HETEROCYCLIC COMPOUNDS
HYDROCARBONS
LIPIDS
NUCLEOTIDES
ORGANIC NITROGEN COMPOUNDS
ORGANIC POLYMERS
ORGANIC SULFUR COMPOUNDS
PROTEINS
ORGANIC COMPOUNDS/DECOMPOSITION
Decomposition in freshwater, 2:42004
ORGANIC COMPOUNDS/ELECTRON SPIN RESONANCE
Investigation of the organomineral compounds of brown coals by the ESR method, 2:40830
ORGANIC NITROGEN COMPOUNDS
See also AMINES
AMINO ACIDS
AZIDES
HEME
HEMOGLOBIN
IMIDES
MELATONIN
METHEMOGLOBIN
NUCLEOTIDES
PROLINE
PROTEINS
PYRIDINES
ORGANIC NITROGEN COMPOUNDS/BIOLOGICAL EFFECTS
Reversions of two proline-requiring auxotrophs of Haemophilus influenzae by N-methyl-N'-nitro-N-nitrosoguanidine and hydrazine, 2:42050
ORGANIC NITROGEN COMPOUNDS/GEOCHEMISTRY
Studies of the emission of elemental nitrogen from coals of different rank and its release under geochemical conditions, 2:40846
ORGANIC NITROGEN COMPOUNDS/HYDROGENATION
Hydrodenitrogenation of petroleum-model-nitrogen compounds, 2:40951
ORGANIC POLYMERS
See also PLASTICS
RESINS
ORGANIC POLYMERS/MECHANICAL PROPERTIES
Advanced composites: mechanical properties and hardware programs for selected resin matrix materials (Boron and graphite fiber reinforcement), 2:41860 (N-76-24364)
ORGANIC SULFUR COMPOUNDS
See also THIOLS
ORGANIC SULFUR COMPOUNDS/ABSORPTION SPECTROSCOPY
Nature and distribution of sulphur compounds in Darius crude, 2:41017
ORGANIC SULFUR COMPOUNDS/CHEMICAL ANALYSIS
Group composition of sulfur compounds in distillate fuels and method for determining this composition, 2:40967
ORGANIC SULFUR COMPOUNDS/POTENTIOMETRY
Nature and distribution of sulphur compounds in Darius crude, 2:41017
ORGANIC SULFUR COMPOUNDS/PRODUCTION
Use of brown coals after the extraction of the montan wax for the production of sulfomethyl derivatives, 2:40808
ORMAK DEVICES/NEUTRAL BEAM SOURCES
Neutral beam injector research and development work in the USA, 2:42302 (BNL-22436)
ORNL RESEARCH REACTOR
See ORR REACTOR
ORR REACTOR/IRRADIATION CAPSULES
Steady state heat transfer in ORR irradiation capsules. Part 2, 2:41503 (ORNL/MIT-232)
ORYZA
See RICE

OSMIUM BASE ALLOYS/THERMODYNAMIC PROPERTIES
Thermodynamic properties of the binary Laves phase compounds of plutonium with the group VIIIa metals, 2:41797
OUABAIN/BIOLOGICAL EFFECTS
Slow phase hemolysis in hypotonic electrolyte solutions, 2:42028
OVARIES/BIOLOGICAL RADIATION EFFECTS
Fractionated x-irradiation damage to developing ovaries in the bonnet monkey (Macaca radiata), 2:42080 (UCD-472-123)
OXIRANS
See EPOXIDES
OXYGEN/BINDING ENERGY
Use of a single venous blood sample to assess oxygen binding to haemoglobin, 2:42038
OXYGEN/CHEMISORPTION
Determination of the rate of chemosorption of oxygen by coals, 2:40819
OXYGEN/PRODUCTION
Coal technology program progress report for January 1977, 2:40731 (ORNL/TM-5819)
Coal technology program progress report for February 1977, 2:40732 (ORNL/TM-5858)
OXYGEN/REDUCTION
Investigation of acid-resistant electrocatalysts for fuel cells, 2:41664 (N-76-24724)
OXYGEN EFFECT (RADIOBIOLOGY)
See OXYGEN
OZONE/CHEMICAL REACTION KINETICS
Reaction kinetics of ozone with sulfur compounds. Final report, 2:41972 (PB-257891)
OZONE/ENVIRONMENTAL TRANSPORT
Instrumental requirements for the measurement of pollutant fluxes (SO_2 and O_3 in surface air), 2:41960 (ANL-75-60(Pt.4))

P

PACEMAKERS
See CARDIAC PACEMAKERS
PACIFIC OCEAN/CONTINENTAL SHELF
Physical oceanography and sediment transport on the Washington continental shelf. Report of progress, October 1975-September 1976 (Pacific Ocean), 2:42146 (RLO-2225-T25-18)
PACIFIC OCEAN/OCEANOGRAPHY
Physical oceanography and sediment transport on the Washington continental shelf. Report of progress, October 1975-September 1976 (Pacific Ocean), 2:42146 (RLO-2225-T25-18)
PALLADIUM 103/MEASURING METHODS
Use of ^{103}Pd as a calibration source for the determination of ^{239}Pu in vivo, 2:42097 (BNWL-2088)
PALLADIUM ALLOYS/HYPERFINE STRUCTURE
Hyperfine interactions in Np Pdsub(3-x)Rhsub(x), 2:41770
PAPER/RECYCLING
Optimization of office paper recovery systems. Final report, 2:41695 (PB-257955)
PARABOLIC COLLECTORS/DESIGN
Development of compound parabolic concentrators for solar thermal applications, 2:41231
PARABOLIC COLLECTORS/PERFORMANCE
Development of compound parabolic concentrators for solar thermal applications, 2:41231
PARAFFIN/CHEMICAL COMPOSITION
Investigations of the bitumens of solid fuels under the electron microscope, 2:40807
PARAFFIN/MASS SPECTROSCOPY
Mass-spectrometric analysis of group composition of saturated petroleum hydrocarbons in crude oil, 2:40968
PARAFFIN/MOLECULAR STRUCTURE
Investigations of the bitumens of solid fuels under the electron microscope, 2:40807
PARAFFIN/PHYSICAL PROPERTIES
Investigations of the bitumens of solid fuels under the electron microscope, 2:40807
PARAFFIN/STRUCTURAL CHEMICAL ANALYSIS
Investigations of the bitumens of solid fuels under the electron microscope, 2:40807
PARAFFINS
See ALKANES
PARAHO PROCESS/SPENT SHALES
Field compaction tests. Research and development program on the disposal of retorted oil shale-Paraho Oil Shale Project. Open file report, 2:41068 (PB-254728)
PARAMETRIC INSTABILITIES
'Enlightement' of a wave barrier under conditions of parametric instability of a pre-barrier plasma, 2:42261
PARATHORMONE/METABOLISM
Metabolism of labeled parathyroid hormone. VII. Attempts to modify hormone deposition (^{125}I tracer technique), 2:42054
PARTICLES/ENVIRONMENTAL TRANSPORT
Numerical modeling of pollutant transport using a Lagrangian marker particle technique, 2:42006 (N-76-28682)
PARTICLES/MONITORING
National air sampling network. Status report, 2:41966 (PB-255288)
PARTITION FUNCTIONS
Effect of intramolecular hydrogen bonding on partition coefficients. Technical note, 2:41871 (AD-A-030683)
PATIENTS/RADIATION DOSE DISTRIBUTIONS
Need for collection of quantitative distribution data for dosimetry and metabolic modeling, 2:42084 (CONF-770101-2)
PATIENTS/WHOLE-BODY COUNTING
Need for collection of quantitative distribution data for dosimetry and metabolic modeling, 2:42084 (CONF-770101-2)
PCA
See POLAR-CAP ABSORPTION
PEACH BOTTOM-2 REACTOR/ENVIRONMENT
Critical evaluation of the nonradiological environmental technical specifications. Volume 3. Peach Bottom Atomic Power Station Units 2 and 3, 2:41494 (ORNL/NUREG/TM-71)
PEACH BOTTOM-3 REACTOR/ENVIRONMENT
Critical evaluation of the nonradiological environmental technical specifications. Volume 3. Peach Bottom Atomic Power Station Units 2 and 3, 2:41494 (ORNL/NUREG/TM-71)
PEANUTS/SOLAR DRYING
Solar energy applications in agriculture: potential, research needs, and adoption strategies, summary and recommendations, 2:41217 (PB-255928)
PEAT/CHEMICAL COMPOSITION
Question of the study of the tendency of peats to undergo oxidation and spontaneous combustion, 2:40818
PEAT/OXIDATION
Question of the study of the tendency of peats to undergo oxidation and spontaneous combustion, 2:40818
PEAT/SPONTANEOUS COMBUSTION
Question of the study of the tendency of peats to undergo oxidation and spontaneous combustion, 2:40818
PELLETS (FUEL)
See FUEL PELLETS
PENNSYLVANIA/COAL MINES
Longwall gob degasification with surface ventilation boreholes above the lower Kittanning coalbed. Report of investigations, 2:40881 (PB-262189)
PERSONNEL
See also MINERS
PERSONNEL/EDUCATION
Indian experience in the training of manpower for nuclear power programme, 2:41306 (IAEA-CN-36/459)
PERSONNEL/INCOME
Comparison of compensation paid scientists and engineers in research and development. 1976 data, 2:42324 (ERDA-77-49)
PERSONNEL/RADIOISOTOPE SCANNING
Development of an improved counter for in vivo plutonium measurement, 2:42109 (BNWL-2088)
PERSONNEL/RADIONUCLIDE KINETICS
Plutonium problem in biological perspective (^{238}Pu and ^{239}Pu distribution and retention in man and laboratory animals and role of Transuranium Registry for personnel data compilation), 2:42094 (BNWL-2088)
Present status of and future plans for ITRI's human and dog chest counting facilities, 2:42106 (BNWL-2088)
PERSONNEL/WHOLE-BODY COUNTING
Detection system for the localization and measurement in vivo of small amounts of photon emitters (Performance of Ge diode scintillation crystal-phototube system for personnel monitoring for ^{238}Pu, ^{239}Pu, and ^{241}Am), 2:42111 (BNWL-2088)
Preliminary evaluations of a high-purity germanium detector system for in vivo measurement of inhaled transuranium elements, 2:42113 (BNWL-2088)
PERSONNEL DOSIMETRY
Development of an anthropomorphic phantom for the calibration of external detectors for the in vivo measurement of plutonium, 2:42114 (BNWL-2088)
PERSONNEL MONITORING
Detection system for the localization and measurement in vivo of small amounts of photon emitters (Performance of Ge diode scintillation crystal-phototube system for personnel monitoring for ^{238}Pu, ^{239}Pu, and ^{241}Am), 2:42111 (BNWL-2088)
Development of an improved counter for in vivo plutonium measurement, 2:42109 (BNWL-2088)
Effects of plutonium redistribution on lung counting, 2:42110 (BNWL-2088)
In vivo plutonium measurement at the Battelle-Northwest whole body center, 2:42104 (BNWL-2088)
LLL plutonium lung counter calibration and discussion of errors, 2:42105 (BNWL-2088)

Methods for the assay of plutonium in vivo: what are the alternatives (^{238}Pu, ^{239}Pu, and ^{241}Am assay in vivo), 2:42108 (BNWL-2088)
Preliminary evaluations of a high-purity germanium detector system for in vivo measurement of inhaled transuranium elements, 2:42113 (BNWL-2088)
Proceedings of the workshop on measurement of heavy elements in vivo, 2:42093 (BNWL-2088)
Ultrasonic measurement techniques used at LLL for determining chest wall thickness and organ shapes (Monitoring personnel for transuranic element deposition in lungs), 2:42112 (BNWL-2088)
PERSONNEL MONITORING/ACTINIDE ISOTOPES
Estimation of lung and skeletal burdens of bone-seeking radionuclides in man from in vivo scintillation measurements of the thorax and the head, 2:42107 (BNWL-2088)
PETROCHEMICALS
See also CHEMICAL FEEDSTOCKS
PETROCHEMICALS/DEMAND FACTORS
Structure and competition within the petrochemical industry and economic impact of 1973-1974 petrochemical shortage. Final report, 2:40974 (PB-254693)
PETROCHEMICALS/PRODUCTION
Liquid-liquid extraction in the petroleum and petrochemical industry, 2:40971
PETROCHEMICALS/TRADE
The impact of the proposed energy conservation program on U.S. foreign trade in manufactures, with an emphasis on petrochemicals. International economics report 1965-1976, 2:40976 (PB-254944)
PETROLEUM
See also OIL WELLS
SHALE OIL
WELL STIMULATION
PETROLEUM/ABSORPTION SPECTROSCOPY
Identifying source of petroleum by infrared spectroscopy, 2:40992
PETROLEUM/ALLOCATIONS
Mandatory Canadian crude oil allocation regulations. Environmental impact statement (final), 2:41634 (PB-255319)
PETROLEUM/CHEMICAL ANALYSIS
Determination of lead in petroleum and petroleum products by atomic absorption spectrometry with a carbon rod atomizer, 2:41013
Determination of trace metals in crude oils by nonflame atomic absorption spectroscopy, 2:41014
Evaluation of carbon rod atomizer for routine analysis of vanadium in crude oil by atomic absorption spectroscopy, 2:41012
Evaluation of a carbon-rod atomizer for routine determination of trace metals by atomic-absorption spectroscopy. Applications to analysis of lubricating oil and crude oil, 2:41016
Mass-spectrometric analysis of group composition of saturated petroleum hydrocarbons in crude oil, 2:40968
Oxygen-bomb coulometric determination of vanadium in oils, 2:41015
PETROLEUM/CHEMICAL COMPOSITION
Compound type separation and characterization studies for a 370° to 535°C boiling distillate of Gach Saran, Iran, crude oil, 2:41021
Experimental investigation of heat capacity of Samotlor crude oil and cuts from this crude, 2:40965
Nature and distribution of sulphur compounds in Darius crude, 2:41017
PETROLEUM/CHROMATOGRAPHY
Chromatography in the petroleum industry, 2:41024
PETROLEUM/CONSUMPTION RATES
Monthly energy review, June 1976, 2:41601 (NTISUB/B-127-76/006)
PETROLEUM/COST
Monthly energy review, June 1976, 2:41601 (NTISUB/B-127-76/006)
PETROLEUM/DATA COMPILATION
Monthly energy review, 2:40911 (NTISUB/B-127-76/009)
Monthly petroleum statistics report, March/April 1976, 2:40914 (NTISUB/B-130-76/004)
PETROLEUM/DENITRIFICATION
Hydrodenitrogenation of petroleum-model-nitrogen compounds, 2:40951
PETROLEUM/DISTRIBUTION
Crude supply alternatives for the northern tier states. Volume I. Executive summary, 2:41643 (PB-255992)
Crude supply alternatives for the northern tier states. Volume II. Technical report, 2:41644 (PB-255993)
PETROLEUM/ENHANCED RECOVERY
Chemistry of petroleum processing and extraction. III, 2:40938
PETROLEUM/FRACTIONATION
Computer simulation of tower operation with two and three crude oil feed inlets, for partial topping of crude, 2:40942
PETROLEUM/HYDROCRACKING
Improvement of raw materials for catalytic cracking, 2:40948
PETROLEUM/INFRARED SPECTRA
Characterization and identification of spilled residual fuel oils by gas chromatography and infrared spectrophotmetry, 2:40993
Identifying source of petroleum by infrared spectroscopy, 2:40992
PETROLEUM/MARKET
Weekly petroleum statistics reports, 1974-1975, 2:40978 (PB-255920)
PETROLEUM/MIDDLE EAST
Middle East oil, 2:41645
PETROLEUM/REFINING
Chemistry of petroleum processing and extraction. II, 2:40949
PETROLEUM/SOCIO-ECONOMIC FACTORS
Middle East oil, 2:41645
PETROLEUM/SPECIFIC HEAT
Experimental investigation of heat capacity of Samotlor crude oil and cuts from this crude, 2:40965
PETROLEUM/SPECTROPHOTOMETRY
Characterization and identification of spilled residual fuel oils by gas chromatography and infrared spectrophotmetry, 2:40993
PETROLEUM/STORAGE
Chemistry of petroleum processing and extraction. III, 2:40938
PETROLEUM/STORAGE FACILITIES
Strategic petroleum reserve. Draft environmental impact statement, 2:40996 (PB-255476)
PETROLEUM/THERMAL CONDUCTIVITY
Thermal conductivity of Upper Cretaceous Malgobek crude oil and narrow cuts from this crude, 2:40999
PETROLEUM/THERMODYNAMIC PROPERTIES
Experimental investigation of heat capacity of Samotlor crude oil and cuts from this crude, 2:40965
PETROLEUM/VISCOSITY
Nomograph for viscosity calculation in binary mixtures, 2:41025
PETROLEUM DEPOSITS
See also OIL FIELDS
PETROLEUM DEPOSITS/EXPLORATION
Contemporary structure of the Lower permian sedimentary strata of the Dnieper-Donets depression, 2:40927
Drilling in the St Lawrence Lowlands of Quebec, 2:40920
Method of structure investigation and deposits research by means of boreholes drilled in circle pattern, 2:40921
Method of determination of abnormally high formation pressures from the data of geophysical investigations of boreholes, 2:40926
New oil and gas exploration and prospecting directions in the Upper Pechora depression of the pre-Ural trough, 2:40925
Oil and gas from the North Sea. I, 2:40929
Paleogeomorphological preconditions of discovery of petroleum and gas-bearing zones in the Jurassic and Triassic complexes of Northern Emba, 2:40923
Phase state of hydrocarbons of the Caspian Depression, 2:40919
Prospects of discovering oil and gas deposits in the jurassic complexes of west siberia, 2:40922
U.s. geological survey's Project BIRDDOG (basic investigation of remotely detectable deposits of oil and gas), 2:40918
PETROLEUM DEPOSITS/GEOCHEMICAL SURVEYS
Oil in the mouths of rivers, 2:40928 (N-76-27643)
PETROLEUM DEPOSITS/GEOLOGY
Phase state of hydrocarbons of the Caspian Depression, 2:40919
PETROLEUM DEPOSITS/GLOBAL ASPECTS
Petroleum and gas resources of foreign countries, 2:40916
PETROLEUM DEPOSITS/PRODUCTION
Production statistics and engineering data: oil in North Dakota, second half 1976, 2:41647
PETROLEUM DEPOSITS/SIMULATION
Our nation's crude oil and natural gas recoveries may be increased by numerical simulation, 2:40917
PETROLEUM DISTILLATES/CHEMICAL ANALYSIS
Determination of trace amounts of total sulfur in light petroleum distillates, 2:41018
PETROLEUM DISTILLATES/CHEMICAL COMPOSITION
Compound-type separation and characterization studies for a 370° to 535°C distillate of Swan Hills (South Field), Alberta, Canada, crude oil, 2:41022
PETROLEUM DISTILLATES/CHROMATOGRAPHY
Compound-type separation and characterization studies for a 370° to 535°C distillate of Wilmington, Calif., crude oil, 2:41023
PETROLEUM DISTILLATES/CORROSIVE EFFECTS
Evaluating refinery process side corrosion inhibitors, 2:40952
PETROLEUM DISTILLATES/HYDROCRACKING
Kinetic model for the prediction of hydrocracker yields, 2:40957
PETROLEUM DISTILLATES/MASS SPECTROSCOPY
Compound-type separation and characterization studies for a 370° to 535°C distillate of Wilmington, Calif., crude oil, 2:41023
PETROLEUM INDUSTRY/CHARGES
Middle East oil, 2:41645
PETROLEUM INDUSTRY/COMPARATIVE EVALUATIONS
Changes in an electric utility's fuel base, 2:41653

PETROLEUM INDUSTRY/COMPETITION
Structure and competition within the petrochemical industry and economic impact of 1973-1974 petrochemical shortage. Final report, 2:40974 (PB-254693)
PETROLEUM INDUSTRY/ECONOMETRICS
Economic analysis of environment and energy in the petroleum refining, electric power, and chemical industries, 2:41638
PETROLEUM INDUSTRY/ENVIRONMENT
Economic analysis of environment and energy in the petroleum refining, electric power, and chemical industries, 2:41638
PETROLEUM INDUSTRY/OFFSHORE OPERATIONS
SEASAT economic assessment. Volume 3: offshore oil and natural gas industry case study and generalization. Final report, Feb 1974-Aug 1975, 2:40931 (N-76-28616)
PETROLEUM INDUSTRY/TURBOMACHINERY
Possible use of expansion turbines in gas and petroleum industries, 2:40947
PETROLEUM PRODUCTS
See also GAS OILS
GASOLINE
KEROSENE
LUBRICATING OILS
PETROLEUM PRODUCTS/ADDITIVES
Influence of polymeric additives on petroleum wax properties, 2:40969
PETROLEUM PRODUCTS/CHEMICAL ANALYSIS
Determination of lead in petroleum and petroleum products by atomic absorption spectrometry with a carbon rod atomizer, 2:41013
Microcoulometric determination of sulphur at sub-ppm levels using the standby technique, 2:41020
PETROLEUM PRODUCTS/CHEMICAL PROPERTIES
Influence of polymeric additives on petroleum wax properties, 2:40969
PETROLEUM PRODUCTS/CHROMATOGRAPHY
Chromatography in the petroleum industry, 2:41024
PETROLEUM PRODUCTS/CLASSIFICATION
Classification of petroleum-derived fuels, 2:40961
PETROLEUM PRODUCTS/CONSUMPTION RATES
Monthly energy review, June 1976, 2:41601 (NTISUB/B-127-76/006)
PETROLEUM PRODUCTS/COST
Monthly energy review, June 1976, 2:41601 (NTISUB/B-127-76/006)
PETROLEUM PRODUCTS/CRYSTAL STRUCTURE
Investigation of the dependence of the properties of carbonaceous materials on the structure of a petroleum coke filler, 2:40960
PETROLEUM PRODUCTS/DATA COMPILATION
Monthly energy review, 2:40911 (NTISUB/B-127-76/009)
Monthly petroleum statistics report, March/April 1976, 2:40914 (NTISUB/B-130-76/004)
PETROLEUM PRODUCTS/DESULFURIZATION
Thermal stability of sulfur compounds in heavy petroleum residual stocks, 2:40980
PETROLEUM PRODUCTS/MARKET
Weekly petroleum statistics reports, 1974-1975, 2:40978 (PB-255920)
PETROLEUM PRODUCTS/MELTING POINTS
Influence of polymeric additives on petroleum wax properties, 2:40969
PETROLEUM PRODUCTS/PHYSICAL PROPERTIES
Influence of polymeric additives on petroleum wax properties, 2:40969
Investigation of the dependence of the properties of carbonaceous materials on the structure of a petroleum coke filler, 2:40960
PETROLEUM PRODUCTS/SOLVENT EXTRACTION
Liquid-liquid extraction in the petroleum and petrochemical industry, 2:40971
PETROLEUM PRODUCTS/THERMODYNAMIC PROPERTIES
Thermal stability of sulfur compounds in heavy petroleum residual stocks, 2:40980
PETROLEUM PRODUCTS/TRADE
Determination of refined petroleum product import fees, 2:40977 (PB-255400)
PETROLEUM REFINERIES/CHEMICAL REACTORS
Experience in operating catalytic reforming reactor with radial feed input and thin bed of catalyst, 2:40944
PETROLEUM REFINERIES/CORROSION PROTECTION
Evaluating refinery process side corrosion inhibitors, 2:40952
PETROLEUM REFINERIES/DESIGN
Computer simulation of tower operation with two and three crude oil feed inlets, for partial topping of crude, 2:40942
PETROLEUM REFINERIES/DISTILLATION
Non-ideal liquid activity coefficients, 2:40959
PETROLEUM REFINERIES/ENERGY CONSERVATION
Energy savings in propylene/propane splitting, 2:40973
PETROLEUM REFINERIES/EQUIPMENT
Analysis of operation of topping tower in high-capacity unit for crude oil distillation, 2:40945
PETROLEUM REFINERIES/FLUE GAS
New tool combats SO_2 emissions, 2:40981
PETROLEUM REFINERIES/GRIDS
Gas distributor grids for high-temperature processes in fluidized bed, 2:40946
PETROLEUM REFINERIES/POLLUTION REGULATIONS
Standards support and environmental impact statement. Volume 1. Proposed standards of performance for petroleum refinery sulfur recovery plants, 2:41993 (PB-257975)
PETROLEUM REFINERIES/POWER DEMAND
Changes in an electric utility's fuel base, 2:41653
PETROLEUM REFINERIES/WASTE MANAGEMENT
Assessment of hazardous waste practices in the petroleum refining industry. Final report, 2:40990 (PB-259097)
PETROLEUM RESIDUES
See HEAVY OILS
PETULA TOKAMAK/ION TEMPERATURE
Measurement of the ion temperature in Petula from the Doppler broadening of impurity lines, 2:42225 (EUR-CEA-FC-862)
PHAGES
See BACTERIOPHAGES
PHANTOMS/DESIGN
Development of an anthropomorphic phantom for the calibration of external detectors for the in vivo measurement of plutonium, 2:42114 (BNWL-2088)
PHASE DIAGRAMS/COMPUTER CALCULATIONS
Theoretical concepts useful in the calculation or storage of phase diagrams of ionic systems, 2:41863 (CONF-770116-1)
PHENACETIN
See ANALGESICS
PHENIX REACTOR/FUEL ELEMENTS
Characteristics and behaviour of the PHENIX fuel element, 2:41394 (IAEA-CN-36/268)
PHENOLS/CHEMICAL REACTIONS
Oxyethylation of the phenols and carboxylic acids of the low-temperature tars from the thermal treatment of coals, 2:40810
PHENOLS/PHYSICAL PROPERTIES
Oxyethylation of the phenols and carboxylic acids of the low-temperature tars from the thermal treatment of coals, 2:40810
PHENOLS/TOXICITY
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
PHENYLETHYLENE
See STYRENE
PHILIPPSBURG-1 REACTOR/POWER TRANSMISSION
Philippsburg nuclear power plant 380 KV switching station, 2:41314 (CS-INIS-27)
PHOSPHATASES/INHIBITION
Bacillus subtilis deoxyuridinetriphosphatase and its bacteriophage PBS2-induced inhibitor, 2:42055
PHOSPHATASES/METABOLISM
Bacillus subtilis deoxyuridinetriphosphatase and its bacteriophage PBS2-induced inhibitor, 2:42055
PHOSPHATES/SPECTROSCOPY
Laser Raman spectrometric determination of oxy-anions in nuclear waste materials, 2:41868 (ARH-SA-279)
PHOSPHITES
See PHOSPHOROUS ACID
PHOSPHORITES/ORE PROCESSING
Recovery of uranium as a by-product of phosphorites from Brazilian northeast area, 2:41076 (IEA-416)
PHOSPHOROUS ACID/GRAVIMETRIC ANALYSIS
Determination of diisopropyl phosphite in sebacate-base lubricants. Determination of phosphorus in diisopropyl phosphite, 2:41007
PHOSPHOROUS ACID/SPECTROPHOTOMETRY
Determination of diisopropyl phosphite in sebacate-base lubricants. Determination of phosphorus in diisopropyl phosphite, 2:41007
PHOTOCHEMICAL OXIDANTS/STANDARDS
Guideline for public reporting of daily air quality: Pollutant Standards Index (PSI). Final report, 2:41992 (PB-257892)
PHOTOEMISSION
(Photon-induced emission)
Theory of solid surfaces. Final scientific report 1 Oct 1972-30 Sep 1975, 2:42209 (AD-A-031022)
PHOTOVOLTAIC POWER PLANTS
See also SOLAR CELL ARRAYS
PHOTOVOLTAIC POWER PLANTS/ECONOMICS
Assessment of cadmium sulfide photovoltaic arrays for large scale electric utility applications. Final report, 2:41199 (PB-255646)
PHTHALOCYANINES/CATALYTIC EFFECTS
Investigation of acid-resistant electrocatalysts for fuel cells, 2:41664 (N-76-24724)
PHWR TYPE REACTORS
See also KANUPP REACTOR

PICKERING-1 REACTOR
PICKERING-2 REACTOR
PICKERING-3 REACTOR
PICKERING-4 REACTOR

PHWR TYPE REACTORS/DESIGN
Innovations in PHWR design, integration of nuclear power stations into power systems and role of small size nuclear power plants in a developing country, 2:41370 (IAEA-CN-36/394)

PHWR TYPE REACTORS/REACTOR PROTECTION SYSTEMS
Reactivity requirements and safety systems for heavy water reactors, 2:41522 (IAEA-CN-36/393)

PICKERING-1 REACTOR
Pickering generating station, 2:41375

PICKERING-2 REACTOR
Pickering generating station, 2:41375

PICKERING-3 REACTOR
Pickering generating station, 2:41375

PICKERING-4 REACTOR
Pickering generating station, 2:41375

PILOT PLANTS/DESIGN
Fluidised combustion, 2:41176

PILOT PLANTS/PERFORMANCE
Fluidized bed solids waste gasifier, 2:41172

PINEAL GLAND/METABOLISM
Age and seasonal differences in the synthesis and metabolism of testosterone by testicular tissue and pineal HIOMT activity of Uinta ground squirrels (Spermophilus armatus), 2:42057

PINS (FUEL)
See FUEL PINS

PIPE FITTINGS/STRESS ANALYSIS
Simplified inelastic (plastic and creep) analysis of pipe elbows subjected to inplane and out-of-plane bending (LMFBR), 2:41412
Three-dimensional stress analyses of mitered elbows, 2:41473

PIPELINE QUALITY GAS
See HIGH BTU GAS

PIPELINES/CONSTRUCTION
Deep water laying of steel pipe-lines using free fall technique, 2:41047
Natural gas pipeline through Lake Traun, 2:41046

PIPELINES/DAMAGE
Operational problems in gas piping system following conversion to natural gas, 2:41045

PIPELINES/DESIGN
Model testing techniques in offshore pipelining, 2:40997

PIPELINES/ELASTICITY
Deep water laying of steel pipe-lines using free fall technique, 2:41047

PIPELINES/FAILURES
High-temperature piping design technology quarterly technical progress report, October-December 1976 (LMFBR), 2:41378 (AI-ERDA-13191)

PIPELINES/MAINTENANCE
Operational problems in gas piping system following conversion to natural gas, 2:41045

PIPELINES/MATERIALS
Experiences in using new steel types for high pressure gas lines constructing, 2:41044

PIPELINES/MECHANICAL PROPERTIES
Experiences in using new steel types for high pressure gas lines constructing, 2:41044

PIPELINES/REPAIR
Operational problems in gas piping system following conversion to natural gas, 2:41045

PIPELINES/STANDARDS
Experiences in using new steel types for high pressure gas lines constructing, 2:41044

PIPELINES/STRESSES
Deep water laying of steel pipe-lines using free fall technique, 2:41047

PIPELINES/WELDED JOINTS
Experiences in using new steel types for high pressure gas lines constructing, 2:41044

PIPES/DESIGN
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
Design of an insulated coaxial pipe assembly for a drilled geothermal wall, 2:41239

PIPES/INSPECTION
Coal technology program progress report for January 1977, 2:40731 (ORNL/TM-5819)

PITCHES/CHEMICAL PROPERTIES
Low-temperature lignite tar: processing and utilization, 2:40812

PITCHES/CHEMICAL REACTIONS
Chemical reactions of the paramagnetic centers of coal pitch and the products of the hydrogenation of coals, 2:40831

PITCHES/PARAMAGNETISM
Chemical reactions of the paramagnetic centers of coal pitch and the products of the hydrogenation of coals, 2:40831

PITCHES/PHYSICAL PROPERTIES
Low-temperature lignite tar: processing and utilization, 2:40812

PLANKTON/ECOLOGY
Decomposition in freshwater, 2:42004

PLANT CELLS/BIOCHEMISTRY
Structure of plant cell walls. Purification and characterization of a β-1,4-galactanase which degrades a structural component of the primary cell walls of dicots, 2:42036

PLANTS (INDUSTRIAL)
See INDUSTRIAL PLANTS

PLANTS (PILOT)
See PILOT PLANTS

PLANTS (POWER)
See POWER PLANTS

PLASMA
See also BEAM-PLASMA SYSTEMS
COLD PLASMA
COLLISIONLESS PLASMA
HIGH-BETA PLASMA
HOT PLASMA
LASER-PRODUCED PLASMA

PLASMA/BOUNDARY LAYERS
A note on the problems of plasma-neutral gas interaction, 2:42236 (N-76-31018)

PLASMA/ELECTROMAGNETIC RADIATION
Experimental and theoretical study of the propagation of high amplitude pulses in a bounded magneto-plasma, 2:42258

PLASMA/ELECTRON DENSITY
Expansion of an electron cloud, 2:42243

PLASMA/LASER RADIATION
Efficient laser light absorption by ion acoustic fluctuations. Interim report, 2:42305 (AD-A-034450)

PLASMA/MATHEMATICAL MODELS
Synopsis of the management of the fusion plasma theory effort of the Division of Magnetic Fusion Energy, 2:42235 (ERDA-77-18)

PLASMA ACCELERATION/MAGNETOHYDRODYNAMICS
Relativistic magnetohydrodynamics of an accelerating plasma, 2:42240

PLASMA ACCELERATION/MATHEMATICAL MODELS
Relativistic magnetohydrodynamics of an accelerating plasma, 2:42240

PLASMA CONFINEMENT
Technology of inertial confinement systems. Report on the IAEA advisory group meeting on the technology of inertial confinement experiments, Dubna, Union of Soviet Socialist Republics, 19-23 July 1976, 2:42220

PLASMA CONFINEMENT/ALPHA PARTICLES
Condition for absolute confinement of alpha particles in axisymmetric tori, 2:42215 (N-76-25021)

PLASMA CONFINEMENT/ELECTRON TEMPERATURE
Conduction heat loss scaling in open field line geometries, 2:42217 (PPPL-1329)

PLASMA DIAGNOSTICS/DOPPLER BROADENING
Measurement of the ion temperature in Petula from the Doppler broadening of impurity lines, 2:42225 (EUR-CEA-FC-862)

PLASMA DIAGNOSTICS/INTERFEROMETERS
CO_2-laser interferometer with direct read-out of phase-shift, 2:42227 (Rijnhuizen-76-100)
Novel interferometer for the measurement of plasma density, 2:42226 (LA-6727-MS)

PLASMA DIAGNOSTICS/INTERFEROMETRY
Study of far-infrared Michelson interferometry based on fast plasma scanning, 2:42228
Study of flow and loss processes at the ends of a linear theta pinch. Progress report for the period June 1, 1976-May 31, 1977, 2:42212 (COO-4020-3)

PLASMA DIAGNOSTICS/X-RAY SPECTRA
Optimum design of an intensity limited pinhole-scintillator, image converter camera model for simultaneous energy, spatial, and time resolution of soft x-rays. Final report, 15 Aug 1975-30 Jun 1976, 2:42223 (AD-A-034405)

PLASMA DRIFT/KINETIC EQUATIONS
Renormalized kinetic theories of anomalous transport due to hydrodynamic fluctuations in strongly magnetized plasma, 2:42237

PLASMA FOCUS DEVICES/NEUTRON SPECTRA
X-ray emission from high temperature plasmas. Annual report, 1 Jul 1975-30 Jun 1976, 2:42230 (N-76-28015)

PLASMA FOCUS DEVICES/NUCLEAR REACTION YIELD
Possible correlation of the neutron yield to the electromechanic work in Mather-type plasma focus devices, 2:42238

PLASMA FOCUS DEVICES/X-RAY SPECTRA
Optimum design of an intensity limited pinhole-scintillator, image converter camera model for simultaneous energy, spatial, and

time resolution of soft x-rays. Final report, 15 Aug 1975-30 Jun 1976, 2:42223 (AD-A-034405)
X-ray emission from high temperature plasmas. Annual report, 1 Jul 1975-30 Jun 1976, 2:42230 (N-76-28015)

PLASMA GUNS/PLASMA INSTABILITY
Instability of electron disturbances in an accelerator with an electron closed drift, 2:42249

PLASMA HEATING
See also HIGH-FREQUENCY HEATING
LASER-RADIATION HEATING

PLASMA HEATING/STOCHASTIC PROCESSES
Cross-field-current driven lower-hybrid instability and stochastic ion heating, 2:42216 (PPPL-1327)

PLASMA INSTABILITY
See also PARAMETRIC INSTABILITIES
PLASMA MACROINSTABILITIES
TRAPPED-PARTICLE INSTABILITY
TWO-STREAM INSTABILITY
Transport processes and instabilities in magnetically confined plasmas with Tsub(itau) approximately Tsub(etau), 2:42234 (AED-Conf-76-506-023)

PLASMA MACROINSTABILITIES
See also TRAPPED-PARTICLE INSTABILITY

PLASMA MACROINSTABILITIES/BOLTZMANN-VLASOV EQUATION
Kinetic theory of MHD instabilities in a nonuniform plasma, 2:42253

PLASMA SIMULATION/RESEARCH PROGRAMS
Synopsis of the management of the fusion plasma theory effort of the Division of Magnetic Fusion Energy, 2:42235 (ERDA-77-18)

PLASMA WAVES
See also ELECTRON PLASMA WAVES
ION ACOUSTIC WAVES

PLASMA WAVES/CONVERSION
RF coupling and mode conversions at the lower hybrid resonance, 2:42269

PLASMA WAVES/COUPLING
RF coupling and mode conversions at the lower hybrid resonance, 2:42269

PLASMA WAVES/CYCLOTRON HARMONICS
Kinetic instability of a two-component plasma at gyrofrequency harmonics, 2:42255

PLASMA WAVES/CYCLOTRON INSTABILITY
Kinetic instability of a two-component plasma at gyrofrequency harmonics, 2:42255

PLASMA WAVES/EXCITATION
Generation of plasma waves by Gaussian laser beam and stimulated Raman scattering, 2:42268
Parametric excitation of surface waves by modulated electric HF field, 2:42259

PLASMA WAVES/LANDAU DAMPING
Damping and dispersion of linear longitudinal oscillations in a multi-component plasma, 2:42262

PLASMA WAVES/WAVE PROPAGATION
Propagation characteristics of cold lower hybrid waves in linear tokamak plasmas, 2:42270

PLASMASPHERE/PLASMA WAVES
Observations of ion cyclotron waves within the plasmasphere by Hawkeye-1. Progress report, 2:42190 (AD-A-034783)

PLASTIC SCINTILLATION DETECTORS/TIMING PROPERTIES
Measurement of scintillation decay times for NE-111 and NE-102 fluors, 2:41927 (EGG-1183-2331)

PLASTICS
See also ORGANIC POLYMERS
POLYETHYLENES

PLASTICS/WEATHERING
Accelerated/abbreviated test methods, study 4 of task 3 (encapsulation) of the low-cost silicon solar array project. Third quarterly progress report, October-December 1976 (Leyan, Tedlar, and polystyrene films), 2:41183 (ERDA/JPL/954458-76/3)

PLATFORM MOUNTED NUCLEAR PLANT
See OFFSHORE NUCLEAR POWER PLANTS

PLATINUM BASE ALLOYS/FRACTURE PROPERTIES
Fracture behavior of a Pt-30% Rh-8% W alloy between room temperature and 1300°c, 2:41156

PLT DEVICES
(Princeton Large Torus.)

PLT DEVICES/NEUTRAL BEAM SOURCES
Neutral beam injector research and development work in the USA, 2:42302 (BNL-22436)

PLT DEVICES/TRAPPED-PARTICLE INSTABILITY
Non-linear saturation of the dissipative trapped-ion mode by mode coupling, 2:42250

PLUMES/MATHEMATICAL MODELS
Use of LARS system for the quantitative determination of smoke plume lateral diffusion coefficients from ERTS images of Virginia, 2:41962 (N-76-24681)

PLUTONIUM
See also PLUTONIUM-ALPHA
PLUTONIUM-BETA
PLUTONIUM-DELTA
PLUTONIUM-EPSILON
PLUTONIUM-GAMMA

PLUTONIUM/BODY BURDEN
Development of an improved counter for in vivo plutonium measurement, 2:42109 (BNWL-2088)

PLUTONIUM/DIFFUSION
Gradients of U, Pu and O at surfaces of (U, Pu)Osub(2+-x), 2:41853

PLUTONIUM/ELECTRIC CONDUCTIVITY
Alloying, radiation damage, and Matthiessen's rule in plutonium, 2:41801

PLUTONIUM/ELECTRONIC STRUCTURE
Localized vs itinerant 5f electrons: a review of the experimental evidence, 2:41769

PLUTONIUM/ENTHALPY
Enthalpy and heat capacity of liquid plutonium and uranium, 2:41806

PLUTONIUM/ENVIRONMENTAL TRANSPORT
Health and Safety Laboratory environmental quarterly, December 1, 1976-March 1, 1977, 2:42085 (HASL-318)

PLUTONIUM/FLUORINATION
Development of F_2 two-step fluorination process for non-aqueous reprocessing, 2:41096 (JAERI-M-6393)

PLUTONIUM/LATTICE VIBRATIONS
Role of lattice vibrations in the determination of the physical properties of the actinides, 2:41773

PLUTONIUM/LIQUID METALS
Model for liquid uranium and plutonium with implications on the adjacent solid phases, 2:41777

PLUTONIUM/MATHEMATICAL MODELS
Model for liquid uranium and plutonium with implications on the adjacent solid phases, 2:41777

PLUTONIUM/NUCLEAR REACTION ANALYSIS
Application of fission track registration technique in the estimation of fissile materials. Analysis of plutonium in solutions of complex matrices, 2:41866

PLUTONIUM/PHYSICAL RADIATION EFFECTS
Alloying, radiation damage, and Matthiessen's rule in plutonium, 2:41801

PLUTONIUM/RECOVERY
Fluorination process studies of plutonium dioxide by fluid-bed, 2:41095 (JAERI-M-6392)

PLUTONIUM/SEGREGATION
Segregation and vapour pressure studies on the uranium-plutonium-carbon system, 2:41839

PLUTONIUM/SOLVENT EXTRACTION
Possible use of carboxylic acids for U/Pu separation in nuclear fuel reprocessing, 2:41090 (AERE-R-8509)
Simulation for control synthesis of a plutonium-uranium extraction process (Scrap recovery), 2:41094 (IS-M-25)

PLUTONIUM/SPECIFIC HEAT
Enthalpy and heat capacity of liquid plutonium and uranium, 2:41806

PLUTONIUM/STORAGE
Tank study committee report, 2:41888 (RFP-2639)

PLUTONIUM/TISSUE DISTRIBUTION
Development of an improved counter for in vivo plutonium measurement, 2:42109 (BNWL-2088)
Development of an anthropomorphic phantom for the calibration of external detectors for the in vivo measurement of plutonium, 2:42114 (BNWL-2088)
Effects of plutonium redistribution on lung counting, 2:42110 (BNWL-2088)
Preliminary evaluations of a high-purity germanium detector system for in vivo measurement of inhaled transuranium elements, 2:42113 (BNWL-2088)

PLUTONIUM/VAPOR PRESSURE
Segregation and vapour pressure studies on the uranium-plutonium-carbon system, 2:41839

PLUTONIUM 238/BODY BURDEN
Calibration for plutonium-238 lung counting at Mound Laboratory, 2:42101 (BNWL-2088)
Determination of heavy elements in humans, 2:42099 (BNWL-2088)
Measurement of transuranic elements in vivo at CRNL (Personnel monitoring at nuclear fuel fabrication plant), 2:42103 (BNWL-2088)
Plutonium problem in biological perspective (^{238}Pu and ^{239}Pu distribution and retention in man and laboratory animals and role of Transuranium Registry for personnel data compilation), 2:42094 (BNWL-2088)

Proceedings of the workshop on measurement of heavy elements in vivo, 2:42093 (BNWL-2088)
Role of chest counting in personnel dosimetry (^{238}Pu and ^{239}Pu lung counting of personnel), 2:42095 (BNWL-2088)
Summary of discussion calibration techniques and errors I, 2:42100 (BNWL-2088)

PLUTONIUM 238/HEALTH HAZARDS
Plutonium problem in biological perspective (^{238}Pu and ^{239}Pu distribution and retention in man and laboratory animals and role of Transuranium Registry for personnel data compilation), 2:42094 (BNWL-2088)

PLUTONIUM 238/INTERNAL IRRADIATION
Measurement of transuranic elements in vivo at CRNL (Personnel monitoring at nuclear fuel fabrication plant), 2:42103 (BNWL-2088)
Role of chest counting in personnel dosimetry (^{238}Pu and ^{239}Pu lung counting of personnel), 2:42095 (BNWL-2088)

PLUTONIUM 238/PERSONNEL MONITORING
Calibration for plutonium-238 lung counting at Mound Laboratory, 2:42101 (BNWL-2088)
In vivo plutonium measurement at the Battelle-Northwest whole body center, 2:42104 (BNWL-2088)
Role of chest counting in personnel dosimetry (^{238}Pu and ^{239}Pu lung counting of personnel), 2:42095 (BNWL-2088)

PLUTONIUM 238/RETENTION FUNCTIONS
In vivo plutonium measurement at the Battelle-Northwest whole body center, 2:42104 (BNWL-2088)
Methods for the assay of plutonium in vivo: what are the alternatives (^{238}Pu, ^{239}Pu, and ^{241}Am assay in vivo), 2:42108 (BNWL-2088)
Plutonium problem in biological perspective (^{238}Pu and ^{239}Pu distribution and retention in man and laboratory animals and role of Transuranium Registry for personnel data compilation), 2:42094 (BNWL-2088)

PLUTONIUM 238/SCINTILLATION COUNTING
Detection system for the localization and measurement in vivo of small amounts of photon emitters (Performance of Ge diode scintillation crystal-phototube system for personnel monitoring for ^{238}Pu, ^{239}Pu, and ^{241}Am), 2:42111 (BNWL-2088)

PLUTONIUM 238/TISSUE DISTRIBUTION
Detection system for the localization and measurement in vivo of small amounts of photon emitters (Performance of Ge diode scintillation crystal-phototube system for personnel monitoring for ^{238}Pu, ^{239}Pu, and ^{241}Am), 2:42111 (BNWL-2088)
In vivo plutonium measurement at the Battelle-Northwest whole body center, 2:42104 (BNWL-2088)
LLL plutonium lung counter calibration and discussion of errors, 2:42105 (BNWL-2088)
Plutonium problem in biological perspective (^{238}Pu and ^{239}Pu distribution and retention in man and laboratory animals and role of Transuranium Registry for personnel data compilation), 2:42094 (BNWL-2088)

PLUTONIUM 239/BODY BURDEN
Determination of heavy elements in humans, 2:42099 (BNWL-2088)
Measurement of transuranic elements in vivo at CRNL (Personnel monitoring at nuclear fuel fabrication plant), 2:42103 (BNWL-2088)
Plutonium problem in biological perspective (^{238}Pu and ^{239}Pu distribution and retention in man and laboratory animals and role of Transuranium Registry for personnel data compilation), 2:42094 (BNWL-2088)
Proceedings of the workshop on measurement of heavy elements in vivo, 2:42093 (BNWL-2088)
Role of chest counting in personnel dosimetry (^{238}Pu and ^{239}Pu lung counting of personnel), 2:42095 (BNWL-2088)
Summary of discussion calibration techniques and errors I, 2:42100 (BNWL-2088)

PLUTONIUM 239/HEALTH HAZARDS
Plutonium problem in biological perspective (^{238}Pu and ^{239}Pu distribution and retention in man and laboratory animals and role of Transuranium Registry for personnel data compilation), 2:42094 (BNWL-2088)

PLUTONIUM 239/INTERNAL IRRADIATION
Measurement of transuranic elements in vivo at CRNL (Personnel monitoring at nuclear fuel fabrication plant), 2:42103 (BNWL-2088)
Role of chest counting in personnel dosimetry (^{238}Pu and ^{239}Pu lung counting of personnel), 2:42095 (BNWL-2088)

PLUTONIUM 239/MEASURING METHODS
Use of ^{109}Pd as a calibration source for the determination of ^{239}Pu in vivo, 2:42097 (BNWL-2088)

PLUTONIUM 239/PERSONNEL MONITORING
In vivo plutonium measurement at the Battelle-Northwest whole body center, 2:42104 (BNWL-2088)
Role of chest counting in personnel dosimetry (^{238}Pu and ^{239}Pu lung counting of personnel), 2:42095 (BNWL-2088)

PLUTONIUM 239/RADIOMETRIC ANALYSIS
Determination of heavy elements in humans, 2:42099 (BNWL-2088)

PLUTONIUM 239/RETENTION FUNCTIONS
In vivo plutonium measurement at the Battelle-Northwest whole body center, 2:42104 (BNWL-2088)
Methods for the assay of plutonium in vivo: what are the alternatives (^{238}Pu, ^{239}Pu, and ^{241}Am assay in vivo), 2:42108 (BNWL-2088)
Plutonium problem in biological perspective (^{238}Pu and ^{239}Pu distribution and retention in man and laboratory animals and role of Transuranium Registry for personnel data compilation), 2:42094 (BNWL-2088)

PLUTONIUM 239/SCINTILLATION COUNTING
Detection system for the localization and measurement in vivo of small amounts of photon emitters (Performance of Ge diode scintillation crystal-phototube system for personnel monitoring for ^{238}Pu, ^{239}Pu, and ^{241}Am), 2:42111 (BNWL-2088)

PLUTONIUM 239/SIMULATORS
Use of ^{109}Pd as a calibration source for the determination of ^{239}Pu in vivo, 2:42097 (BNWL-2088)

PLUTONIUM 239/TISSUE DISTRIBUTION
Canine bone dynamics, 2:42090 (UCD-472-123)
Detection system for the localization and measurement in vivo of small amounts of photon emitters (Performance of Ge diode scintillation crystal-phototube system for personnel monitoring for ^{238}Pu, ^{239}Pu, and ^{241}Am), 2:42111 (BNWL-2088)
In vivo plutonium measurement at the Battelle-Northwest whole body center, 2:42104 (BNWL-2088)
LLL plutonium lung counter calibration and discussion of errors, 2:42105 (BNWL-2088)
Plutonium problem in biological perspective (^{238}Pu and ^{239}Pu distribution and retention in man and laboratory animals and role of Transuranium Registry for personnel data compilation), 2:42094 (BNWL-2088)
Summary of discussion calibration techniques and errors I, 2:42100 (BNWL-2088)

PLUTONIUM 240/BODY BURDEN
Measurement of transuranic elements in vivo at CRNL (Personnel monitoring at nuclear fuel fabrication plant), 2:42103 (BNWL-2088)

PLUTONIUM 240/INTERNAL IRRADIATION
Measurement of transuranic elements in vivo at CRNL (Personnel monitoring at nuclear fuel fabrication plant), 2:42103 (BNWL-2088)

PLUTONIUM ALLOYS
See also PLUTONIUM BASE ALLOYS

PLUTONIUM ALLOYS/CRYSTAL STRUCTURE
Crystal structure of the compounds Pu_3X_4 (X = Rh, Ir), 2:41766

PLUTONIUM ALLOYS/DEPOSITION
Sputter-deposition of metastable Ta-Pu, Ag-Pu and Co-Pu alloys, 2:41759

PLUTONIUM ALLOYS/ELECTRONIC SPECIFIC HEAT
Calorimetric study of the intermetallic compounds UAl_2 and $PuAl_2$, 2:41807

PLUTONIUM ALLOYS/FORMATION HEAT
Heat of formation of plutonium alloys, 2:41802

PLUTONIUM ALLOYS/PHASE DIAGRAMS
Some results of a study of the Pu-Al-Ga phase diagram, 2:41765

PLUTONIUM ALLOYS/SPUTTERING
Sputter-deposition of metastable Ta-Pu, Ag-Pu and Co-Pu alloys, 2:41759

PLUTONIUM ALLOYS/THERMODYNAMIC PROPERTIES
Thermodynamic properties of the binary Laves phase compounds of plutonium with the group VIIIa metals, 2:41797

PLUTONIUM BASE ALLOYS/CRYSTAL STRUCTURE
Relationship between structure and some properties of delta-Pu and γ-U alloys, 2:41821

PLUTONIUM BASE ALLOYS/CRYSTAL-PHASE TRANSFORMATIONS
Kinetics of the delta to alpha transformation in plutonium rich Pu-Ga alloys, 2:41774

PLUTONIUM BASE ALLOYS/ELASTICITY
Single-crystal elastic constants of a plutonium-gallium alloy, 2:41792

PLUTONIUM BASE ALLOYS/ELECTRIC CONDUCTIVITY
Alloying, radiation damage, and Matthiessen's rule in plutonium, 2:41801

PLUTONIUM BASE ALLOYS/PHYSICAL RADIATION EFFECTS
Alloying, radiation damage, and Matthiessen's rule in plutonium, 2:41801
Relationship between structure and some properties of delta-Pu and γ-U alloys, 2:41821

PLUTONIUM BASE ALLOYS/SELF-DIFFUSION
Melting-diffusion correlation in the plutonium-zirconium alloys, 2:41778

PLUTONIUM BASE ALLOYS/SOLID SOLUTIONS
Splat cooling of some actinide alloys, 2:41760

PLUTONIUM BASE ALLOYS/SPLAT COOLING
Splat cooling of some actinide alloys, 2:41760
PLUTONIUM BASE ALLOYS/TENSILE PROPERTIES
Effect of strain rate on the tensile properties of α- and delta-stabilized plutonium, 2:41788
PLUTONIUM BASE ALLOYS/THERMAL DIFFUSIVITY
Heat transport properties of a delta-stabilized Pu-1 wt.% Ga alloy from room temperature to 500 degrees C, 2:41800
PLUTONIUM CARBIDES/EVAPORATION
Evaporation behaviour of the ternary uranium plutonium carbides, 2:41846
PLUTONIUM CARBIDES/PHASE DIAGRAMS
Some constitutional studies on uranium-carbon- and plutonium-carbon-rhenium and technetium systems, 2:41827
Some phase relationships and equilibria for the uranium-plutonium monocarbonitrides including the effects of oxygen on some equilibria, 2:41833
PLUTONIUM CARBIDES/PRODUCTION
Technological aspects of fuel manufacture for different power reactors, 2:41085 (IAEA-CN-36/352)
PLUTONIUM CARBIDES/SEGREGATION
Segregation and vapour pressure studies on the uranium-plutonium-carbon system, 2:41839
PLUTONIUM CARBIDES/SPECIFIC HEAT
Specific heat of PuCsub(1-x) and Pu_2C_3 from 10 to 300 K, 2:41841
PLUTONIUM CARBIDES/VAPOR PRESSURE
Evaporation behaviour of the ternary uranium plutonium carbides, 2:41846
Segregation and vapour pressure studies on the uranium-plutonium-carbon system, 2:41839
PLUTONIUM COMPOUNDS/CRYSTAL-PHASE TRANSFORMATIONS
Some actinides double orthovanadates and orthoarsenates: structural 'evolution' due to cationic and anionic substitutions, 2:41779
PLUTONIUM DIOXIDE/CHEMICAL COMPOSITION
Determination of oxygen potentials of hyperstoichiometric U-Pu dioxides in the temperature range 1500-1850 K, 2:41826
PLUTONIUM DIOXIDE/CREEP
Thermal creep of UO_2 and UO_2-PuO_2 in the stress range between 40 and 100 N/mm^2, 2:41836
PLUTONIUM DIOXIDE/DIFFUSION
Gradients of U, Pu and O at surfaces of (U, Pu)Osub(2+-x), 2:41853
PLUTONIUM DIOXIDE/FABRICATION
Status of the development of mixed oxide fuels in PNC, 2:41489 (IAEA-CN-36/553)
PLUTONIUM DIOXIDE/FLUORINATION
Development of F_2 two-step fluorination process for non-aqueous reprocessing, 2:41096 (JAERI-M-6393)
Fluorination process studies of plutonium dioxide by fluid-bed, 2:41095 (JAERI-M-6392)
PLUTONIUM DIOXIDE/LATTICE PARAMETERS
Low temperature lattice parameters of the actinide dioxides, 2:41830
PLUTONIUM DIOXIDE/PHYSICAL RADIATION EFFECTS
Alpha radiation damage in the actinide dioxides, 2:41859
Structural changes in actinide dioxides under self- and reactor irradiation, 2:41857
PLUTONIUM DIOXIDE/STATISTICAL MODELS
Unified model for defects in substoichiometric plutonium dioxide and uranium plutonium mixed oxides, 2:41828
PLUTONIUM FLUORIDES/FLUORIDE VOLATILITY PROCESS
Adaptation of the continuous cold trap system of fluidized-bed to the fluoride volatility process, 2:41078 (JAERI-M-6405)
PLUTONIUM NITRIDES/PHASE DIAGRAMS
Some phase relationships and equilibria for the uranium-plutonium monocarbonitrides including the effects of oxygen on some equilibria, 2:41833
PLUTONIUM NITRIDES/PRODUCTION
Technological aspects of fuel manufacture for different power reactors, 2:41085 (IAEA-CN-36/352)
PLUTONIUM NITRIDES/THERMODYNAMIC PROPERTIES
Fabrication and high temperature thermodynamic and transport properties of PuN, 2:41838
PLUTONIUM OXIDES/CHEMICAL BONDS
Electronic properties of actinide oxides, 2:41829
PLUTONIUM OXIDES/ELECTRIC CONDUCTIVITY
Electrical conductivity of (U,Pu) Osub(2+-x) in the pure state and with addition of molybdenum, 2:41847
PLUTONIUM OXIDES/EVAPORATION
Advances in vapour pressure studies over liquid uranium plutonium oxides up to 5000K, 2:41845
PLUTONIUM OXIDES/PHYSICAL RADIATION EFFECTS
Lattice defects and irradiation damage in ThO_2, UO_2 and $(U,Pu)O_2$, 2:41854
PLUTONIUM OXIDES/THERMODYNAMIC PROPERTIES
Thermodynamic properties of (U,Pu)Osub(2+-x) described by a cluster model, 2:41840
Thermodynamic studies at higher temperatures of the phase relationships of substoichiometric plutonium and uranium/plutonium oxides, 2:41848
PLUTONIUM OXIDES/VAPOR PRESSURE
Advances in vapour pressure studies over liquid uranium plutonium oxides up to 5000K, 2:41845
PLUTONIUM RECYCLE
Experience with Pu-recycle fuel for large light water reactors in the Federal Republic of Germany, 2:41318 (IAEA-CN-36/558)
PLUTONIUM RECYCLE/ECONOMICS
Plutonium use - present status and perspectives, 2:41445 (IAEA-CN-36/477)
PLUTONIUM RECYCLE/PLANNING
Plutonium utilization in thermal and fast reactor in Japan, 2:41303 (IAEA-CN-36/162)
Plutonium use - present status and perspectives, 2:41445 (IAEA-CN-36/477)
Plutonium fuel and fuel elements for power reactors, 2:41444 (IAEA-CN-36/353)
Pu utilization in fast-breeder and in light-water reactors in Italy, 2:41320 (IAEA-CN-36/577)
PLUTONIUM-ALPHA/CRYSTAL-PHASE TRANSFORMATIONS
βyieldsα phase transformation in unalloyed plutonium after full and partial β phase formation, 2:41768
Microstructure and kinetics of the plutonium βyieldsα and γyieldsα transformations, 2:41761
PLUTONIUM-ALPHA/DEFORMATION
Internal stresses in α-plutonium during deformation, 2:41791
PLUTONIUM-ALPHA/ELASTICITY
Sound velocity and elastic moduli in α-plutonium at pressures to 50 Kbar, 2:41789
PLUTONIUM-ALPHA/ELECTRONIC STRUCTURE
Study of the modification of the 5f states in the α and delta-plutonium phases by X-ray absorption spectroscopy, 2:41764
PLUTONIUM-ALPHA/ENERGY-LEVEL TRANSITIONS
Analysis of the α-Pu 5f electron distribution by X-ray emission spectroscopy, 2:41763
PLUTONIUM-ALPHA/FRACTURE PROPERTIES
Plane strain fracture toughness of unalloyed alpha phase plutonium, 2:41089
PLUTONIUM-ALPHA/RELAXATION
Analysis of the α-Pu 5f electron distribution by X-ray emission spectroscopy, 2:41763
PLUTONIUM-ALPHA/STRESSES
Internal stresses in α-plutonium during deformation, 2:41791
PLUTONIUM-ALPHA/TENSILE PROPERTIES
Effect of strain rate on the tensile properties of α- and delta-stabilized plutonium, 2:41788
PLUTONIUM-BETA/CRYSTAL-PHASE TRANSFORMATIONS
βyieldsα phase transformation in unalloyed plutonium after full and partial β phase formation, 2:41768
Kinetics of the βyieldsα transformation in unalloyed plutonium after partial formation of the β phase, 2:41775
Microstructure and kinetics of the plutonium βyieldsα and γyieldsα transformations, 2:41761
PLUTONIUM-DELTA/CRYSTAL STRUCTURE
Relationship between structure and some properties of delta-Pu and γ-U alloys, 2:41821
PLUTONIUM-DELTA/ELECTRONIC STRUCTURE
Study of the modification of the 5f states in the α and delta-plutonium phases by X-ray absorption spectroscopy, 2:41764
PLUTONIUM-DELTA/PERMEABILITY
Impurity diffusion of cobalt in plutonium, 2:41798
PLUTONIUM-DELTA/PHYSICAL RADIATION EFFECTS
Relationship between structure and some properties of delta-Pu and γ-U alloys, 2:41821
PLUTONIUM-DELTA/TENSILE PROPERTIES
Effect of strain rate on the tensile properties of α- and delta-stabilized plutonium, 2:41788
PLUTONIUM-EPSILON/PERMEABILITY
Impurity diffusion of cobalt in plutonium, 2:41798
PLUTONIUM-GAMMA/CRYSTAL-PHASE TRANSFORMATIONS
Microstructure and kinetics of the plutonium βyieldsα and γyieldsα transformations, 2:41761
PNEUMOCOCCUS/BINDING ENERGY
Binding and entry of DNA in pneumococcal transformation, 2:42034
Single-strand breakage on binding of DNA to cells in the genetic transformation of Diplococcus pneumoniae, 2:42048
PNEUMOCOCCUS/GENETICS
Single-strand breakage on binding of DNA to cells in the genetic transformation of Diplococcus pneumoniae, 2:42048

POLAND/COAL PREPARATION PLANTS
Technical progress in development of mechanical coal preparation in Poland in the five year period 1971-1975, 2:40901
POLAR BLACKOUT
See POLAR-CAP ABSORPTION
POLAR SUBSTORMS
See MAGNETIC BAYS
POLAR-CAP ABSORPTION
The correlation of the 10 to 30 MeV proton flux from the NOAA satellites and the Thule 30 MHz riometer. Technical memo, 2:42186 (PB-256 102)
POLLUTION
(For nonradioactive pollution only; see also CONTAMINATION.)
See also AIR POLLUTION
CHEMICAL EFFLUENTS
NOISE POLLUTION
THERMAL POLLUTION
WATER POLLUTION
POLLUTION/BIBLIOGRAPHIES
Time series forecasting and prediction (a bibliography with abstracts). Report for 1964-Jan 1977, 2:41666 (NTIS/PS-77/0042)
POLLUTION CONTROL AGENCIES/MANAGEMENT
Guideline for public reporting of daily air quality: Pollutant Standards Index (PSI). Final report, 2:41992 (PB-257892)
POLLUTION CONTROL EQUIPMENT
See also AIR FILTERS
ELECTROSTATIC PRECIPITATORS
SCRUBBERS
POLLUTION CONTROL EQUIPMENT/DESIGN
New methods for reducing visible emissions of diesel engines, 2:41752
POLLUTION REGULATIONS/ECONOMIC IMPACT
Economic and financial impacts of federal air and water pollution controls on the electric utility industry. Executive summary. Final report, 2:41649 (PB-254307)
Economic and financial impacts of federal air and water pollution controls on the electric utility industry. Final technical report, 2:41652 (PB-254308)
POLLUTION REGULATIONS/ENVIRONMENTAL IMPACT STATEMENTS
Standards support and environmental impact statement. Volume 1. Proposed standards of performance for petroleum refinery sulfur recovery plants, 2:41993 (PB-257975)
POLYCYCLIC AROMATIC HYDROCARBONS/AEROSOL MONITORING
Gas chromatographic analysis of air pollutants, 2:41985
POLYETHYLENES/DECOMPOSITION
Contribution to the study of initiation and propagation mechanisms of treeing in polyethylene for high voltage cables, 2:41293
POLYETHYLENES/ELECTRICAL INSULATION
Contribution to the study of initiation and propagation mechanisms of treeing in polyethylene for high voltage cables, 2:41293
High voltage polyethylene insulated cables from 63 to 225 kV and their fittings, 2:41291
Materials for high voltage cables with polyethylene or chemically cross-linked polyethylene insulation, 2:41292
POLYNUCLEAR HYDROCARBONS
See CONDENSED AROMATICS
PONDS
See LAKES
PONDS (COOLING)
See COOLING PONDS
POPULATION DYNAMICS/BIBLIOGRAPHIES
Time series forecasting and prediction (a bibliography with abstracts). Report for 1964-Jan 1977, 2:41666 (NTIS/PS-77/0042)
POROUS MATERIALS/HEAT TRANSFER
Heat and mass transfer in porous rock fragments, 2:42139 (PB-258102)
POROUS MATERIALS/MASS TRANSFER
Heat and mass transfer in porous rock fragments, 2:42139 (PB-258102)
PORTUGAL/NUCLEAR POWER
Advisability of nuclear energy: analysis from the point of view of the electric generating system, 2:41441
POTASSIUM/ABSORPTION SPECTROSCOPY
Novel wet-digestion procedure for trace-metal analysis of coal by atomic absorption, 2:40836
POTASSIUM/BIOLOGICAL EFFECTS
Slow phase hemolysis in hypotonic electrolyte solutions, 2:42028
POTASSIUM/PHYSICAL PROPERTIES
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
POTASSIUM/THERMODYNAMIC PROPERTIES
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
POTASSIUM ALLOYS/PHYSICAL PROPERTIES
Study of NaK flow and heat transfer, (1). Tabulation of the physical quantities of NaK, 2:41796 (PNC-N-941-75-113)
POWDERS/CHEMICAL REACTIONS
Investigation of some physicochemical processes in pitch-coke compositions, 2:40829
POWDERS/SURFACE PROPERTIES
Investigation of some physicochemical processes in pitch-coke compositions, 2:40829
POWDERS/WETTABILITY
Investigation of some physicochemical processes in pitch-coke compositions, 2:40829
POWER CONDITIONING CIRCUITS/DESIGN
Electric power-conditioning for a thermionic generator (Space satellite thermionic reactor), 2:41428
POWER GENERATION/ECONOMETRICS
Economic analysis of environment and energy in the petroleum refining, electric power, and chemical industries, 2:41638
POWER GENERATION/ECONOMICS
Changes in an electric utility's fuel base, 2:41653
POWER GENERATION/ENVIRONMENT
Economic analysis of environment and energy in the petroleum refining, electric power, and chemical industries, 2:41638
POWER GENERATION/ENVIRONMENTAL EFFECTS
Changes in an electric utility's fuel base, 2:41653
POWER GENERATION/FORECASTING
Changes in an electric utility's fuel base, 2:41653
POWER GENERATION/RELIABILITY
Report on equipment availability for the ten-year period, 1966-1975, 2:41648 (EEI-76-85)
POWER PLANTS
See also DUAL-PURPOSE POWER PLANTS
HYDROELECTRIC POWER PLANTS
NUCLEAR POWER PLANTS
SOLAR POWER PLANTS
WIND POWER PLANTS
POWER PLANTS/CONTROL SYSTEMS
Application of the factorial experiment to the analysis of the effectiveness of control systems, 2:41271
POWER PLANTS/DESIGN
Osmosis process for producing energy, 2:41251
POWER PLANTS/ON-LINE CONTROL SYSTEMS
Design of control systems for electric power systems, 2:41269
Energy supply problems of process control computers in power plants, 2:41263
POWER REACTORS
See also BELOYARSK-2 REACTOR
BIBLIS-A REACTOR
BOHUNICE A-1 REACTOR
CLINCH RIVER BREEDER REACTOR
CONNECTICUT YANKEE REACTOR
DESALINATION REACTORS
EBR-2 REACTOR
KANUPP REACTOR
KOZLODUY-1 REACTOR
KOZLODUY-2 REACTOR
MILLSTONE-1 REACTOR
MONTICELLO REACTOR
N-REACTOR
OBRIGHEIM REACTOR
PEACH BOTTOM-2 REACTOR
PEACH BOTTOM-3 REACTOR
PHENIX REACTOR
PHILIPPSBURG-1 REACTOR
PICKERING-1 REACTOR
PICKERING-2 REACTOR
PICKERING-3 REACTOR
PICKERING-4 REACTOR
PROCESS HEAT REACTORS
QUAD CITIES-1 REACTOR
QUAD CITIES-2 REACTOR
SGHWR REACTOR
SNR-1 REACTOR
STADE REACTOR
TARAPUR-1 REACTOR
THREE MILE ISLAND-1 REACTOR
THREE MILE ISLAND-2 REACTOR
THTR-300 REACTOR
TIHANGE REACTOR
VERMONT YANKEE REACTOR
VRAIN REACTOR
WWER TYPE REACTORS
POWER REACTORS/FUEL MANAGEMENT
Solution of the fuel burnup control problem with a controlling neutron equation and Walsh functions, 2:41461
POWER REACTORS/PLUTONIUM RECYCLE
Plutonium fuel and fuel elements for power reactors, 2:41444 (IAEA-CN-36/353)

POWER SUPPLIES/SPECIFICATIONS
Power supply to the air-core transformer coils of a large tokamak by a multi-stage inductive energy storage system. Optimal design of the electric circuits by a simplex method, 2:42303 (JAERI-M-6467)
POWER SYSTEMS/CONTROL SYSTEMS
Computer-operated ripple control command unit, 2:41294
POWER SYSTEMS/LOAD MANAGEMENT
Formulation and computer methods of load flow studies, 2:41289
POWER SYSTEMS/MANAGEMENT
Minutes of and commentary on conference on utility load management held in Brussels on November 12-13, 1974 under the auspices of the NATO Committee on challenges of modern society, 2:41246 (PB-254297)
POWER SYSTEMS/PROCESS CONTROL
Computer-operated ripple control command unit, 2:41294
POWER TRANSMISSION/COST
Superconducting power transmission: the perils and promise, 2:41299
POWER TRANSMISSION/HVDC SYSTEMS
High voltage dc transmission applications offshore, 2:41297
POWER TRANSMISSION/SUPERCONDUCTING CABLES
Superconducting power transmission: the perils and promise, 2:41299
PRASEODYMIUM PERCHLORATES/OSMOSIS
Isopiestic determination of the activity coefficients of some aqueous rare earth electrolyte solutions at 25°C. II. The rare earth perchlorates, 2:41874
PRASEODYMIUM PERCHLORATES/THERMODYNAMIC PROPERTIES
Heats of dilution of some aqueous rare earth electrolyte solutions at 25°C. I. Rare earth perchlorates, 2:41873
PRESSURE SUPPRESSION/RESEARCH PROGRAMS
Reactor containment analysis for BWR suppression systems. Progress report, October-December 1976, 2:41538 (UCRL-50045-76-4)
PRESSURE VESSELS/CRACKS
Cracking of reinforced concrete heated cylindric containers in the presence of thrusting slabs, 2:41482
PRESSURE VESSELS/DESIGN
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
Development of an integrated prestressed concrete vessel for water cooled reactors, 2:41324
Prestressed concrete pressure vessel with hot liner for PWR nuclear reactors, 2:41339
PRESSURE VESSELS/FRACTURE PROPERTIES
Cracking of reinforced concrete heated cylindric containers in the presence of thrusting slabs, 2:41482
Determining fracture properties of reactor vessel forging materials, weldments, and bolting materials. Final report, 2:41783 (PB-257563)
PRESSURE VESSELS/IN-SERVICE INSPECTION
Reproducibility problems of in-service ultrasonic testing results, 2:41470 (INIS-mf-3389)
PRESSURE VESSELS/INSPECTION
Coal technology program progress report for January 1977, 2:40731 (ORNL/TM-5819)
PRESSURE VESSELS/RADIATION DOSES
Study of radiation dosage to structural components in nuclear reactors. Final report (BWR; PWR), 2:41536 (PB-257567)
PRESSURE VESSELS/STRESS ANALYSIS
Assessment of non-linear analysis finite element program (NONSAP) for inelastic analysis, 2:41465 (BNL-NUREG-50615)
Interpretation of finite element stresses according to ASME Section III, 2:41477
ISA: Ineractive Stress Analysis. A program for plane stress, plane strain and axisymmetric analysis of structural continua. User's manual (HTGR), 2:41472 (ORNL/Sub/4164-2)
PRESSURE VESSELS/ULTRASONIC TESTING
Reproducibility problems of in-service ultrasonic testing results, 2:41470 (INIS-mf-3389)
PRESSURE VESSELS/WELDING
Thermal strain effect of welding on the properties and stress state of welded joints in the pressure vessel of the A 1 reactor, 2:41374 (VR-688/76)
PRESSURIZED WATER REACTORS
See PWR TYPE REACTORS
PRESSURIZERS/QUALITY ASSURANCE
Quality assurance of production of steam generators and volume compensators for WWER-440 type nuclear power plants, 2:41336 (INIS-mf-3389)
PRIMARY COOLANT CIRCUITS
Gas-cooled fast breeder reactor. Quarterly progress report, November 1, 1976-January 31, 1977, 2:41384 (GA-A-14240)
PRIMARY COOLANT CIRCUITS/ARC WELDING
How nuclear welding differs from other kinds, 2:41330 (CS-INIS-3)
PRIMARY COOLANT CIRCUITS/IN-SERVICE INSPECTION
In-service inspection of life and reliability of pipe system of WWER 1000 primary circuit, 2:41335 (INIS-mf-3389)
PRIMARY COOLANT CIRCUITS/RADIOACTIVITY TRANSPORT
Tritium formation and elimination in light-water electronuclear plants, 2:41497 (IAEA-CN-36/238)
PRIMARY COOLANT CIRCUITS/REACTOR MATERIALS
Caustic stress corrosion cracking (LMFBR), 2:41388 (HEDL-SA-1122)
PRIMARY COOLANT CIRCUITS/TWO-PHASE FLOW
Summary on experimental methods for statistical transient analysis of two-phase gas-liquid flow (BWR, PWR, and LMFBR), 2:41312 (ANL-76-75)
PRIMARY COSMIC RADIATION/COSMIC RAY FLUX
Measurement of hard cosmic rays in September 1973 by Mars-4, Mars-5 and Mars-7, 2:42151 (N-76-29148)
PRINCETON LARGE TORUS
See PLT DEVICES
PROCESS HEAT REACTORS/COAL GASIFICATION
Assessment of very high-temperature reactors in process applications. Appendix III. Engineering evaluation of process heat applications for very-high temperature reactors, 2:40788 (ORNL/TM-5411)
Production of refined intermediate fuels with high temperature reactors, 2:41450 (IAEA-CN-36/376)
PROCESS HEAT REACTORS/COAL LIQUEFACTION
Assessment of very high-temperature reactors in process applications. Appendix III. Engineering evaluation of process heat applications for very-high temperature reactors, 2:40788 (ORNL/TM-5411)
Production of refined intermediate fuels with high temperature reactors, 2:41450 (IAEA-CN-36/376)
PROCESS HEAT REACTORS/DISTRICT HEATING
Experimental study of utilization of nuclear power heating plants for big towns and industrial agglomerations in Russia, 2:41451 (IAEA-CN-36/465)
Use of nuclear reactors for central heat supply and district heating, 2:41449 (IAEA-CN-36/338)
PROCESS HEAT REACTORS/FEASIBILITY STUDIES
Mobile nuclear power plants: initial feasibility study. Research report (Transportable plants for industrial energy), 2:41427 (PB-258232)
PROCESS HEAT REACTORS/HYDROGEN PRODUCTION
Assessment of very high-temperature reactors in process applications. Appendix III. Engineering evaluation of process heat applications for very-high temperature reactors, 2:40788 (ORNL/TM-5411)
Production of refined intermediate fuels with high temperature reactors, 2:41450 (IAEA-CN-36/376)
PROCESS HEAT REACTORS/PLANNING
Near term feasibility of nuclear reactor for sea-water desalting: coupling of standard condensing nuclear power stations to low grade heat multieffect distillation plants, 2:41447 (IAEA-CN-36/52)
Reactor waste heat utilization and district heating reactors. Nuclear district heating in Sweden - Regional reject heat utilization schemes and small heat-only reactors, 2:41448 (IAEA-CN-36/275)
PROCESS HEAT REACTORS/USES
Consequences of the energy crisis, 2:41631
Uses of nuclear energy in metallurgy - research and development, 2:41452 (TRINEC-P-926)
PROCESSING (WASTES)
See WASTE PROCESSING
PRODUCER GAS/COMBUSTION PROPERTIES
Process of combustion of a mixture of natural, coking, and blast-furnace gases in a reversible combined burner with controlled spray, 2:41031
PROJECT (VELA)
See VELA PROJECT
PROJECTILES/ACCELERATION
Equations of motion for a mass particle elastically mounted on a disk subjected to transverse and rotational accelerations (Simulation of projectile accelerated down a rifled gun tube), 2:41879 (SAND-76-8262)
PROLINE/BIOSYNTHESIS
Synteny between the Pro^+ marker and human glutamate oxaloacetate transaminase, 2:42044
PROMETHAZINE
See AMINES
PROPANE/COMBUSTION KINETICS
Hybrid computer program for rapidly solving flowing or static chemical kinetic problems involving many chemical species, 2:41963 (N-76-29382)
PROPANE/FLUIDIZED-BED COMBUSTION
Fluidized vortex incineration of waste. Final report May 70-Aug 74, 2:41175 (PB-258071)

PROPANE/FRACTIONATION
Energy savings in propylene/propane splitting, 2:40973
PROPANE/OXIDATION
Research on electrochemical energy conversion systems. Final technical report, 1 Jul 1975-30 Jun 1976 (Trifluoromethanesulfonic acid electrolyte), 2:41663 (AD-A-034454)
PROPENE
See PROPYLENE
PROPORTIONAL COUNTERS/DESIGN
Fabrication of a focusing soft x-ray collector payload. Final report, 22 Nov 1972-30 Jun 1976, 2:41929 (N-76-30527)
PROPYLENE/FRACTIONATION
Energy savings in propylene/propane splitting, 2:40973
PROSTAGLANDINS/BIOLOGICAL EFFECTS
Contractility of rat testicular seminiferous tubules in vitro: prostaglandin F/sub lα/ and indomethacin, 2:42067
Indomethacin induces rat uterine contractions in vitro and alters reactivity to calcium and acetylcholine, 2:42068
PROTEINS/BIOSYNTHESIS
Studies of temperature sensitive mutants of bacteriophage Qβ, defective in both replication and translation, 2:42045
PROTEINS/EXCRETION
Aminoaciduria and proteinuria in rats after a single intraperitoneal injection of Ni(II), 2:42126
PROTEINS/MOLECULAR BIOLOGY
Neutron diffraction analysis of the structure of retinal photoreceptor membranes and rhodopsin, 2:42018 (BNL-50453)
PROTEINS/MOLECULAR STRUCTURE
Direct methods for the analysis of lamellar neutron diffraction from oriented multilayers: a difference patterson deconvolution approach, 2:42020 (BNL-50453)
Neutron diffraction studies of oriented retinal rods, 2:42022 (BNL-50453)
Neutron diffraction studies of vertebrate striated muscle, 2:42024 (BNL-50453)
Neutron scattering measurements with the label triangulation method on the 50 S subunit of E. coli ribosomes, 2:42027 (BNL-50453)
Protein pair distance determination in the 30 S ribosoma subunit of E. coli, 2:42026 (BNL-50453)
PROTEINS/NEUTRON DIFFRACTION
Neutron scattering by collagen, 2:42023 (BNL-50453)
Neutron scattering measurements with the label triangulation method on the 50 S subunit of E. coli ribosomes, 2:42027 (BNL-50453)
Small-angle scattering of proteins in solution, 2:42025 (BNL-50453)
PROTEINS/SMALL ANGLE SCATTERING
Small-angle scattering of proteins in solution, 2:42025 (BNL-50453)
PROTON DETECTION/SEMICONDUCTOR DETECTORS
S^3 solid state proton experiment. Part II. Mean energy of a finite energy passband. Technical memo, 2:41930 (PB-257833)
PROTON REACTIONS
Low fluxes of x rays. Final report (Interactions of high-energy protons with spacercraft materials and typical materials for scintillation detectors), 2:41936 (N-76-30279)
PROTOPLASTS
See PLANT CELLS
PSORALEN/BIOLOGICAL EFFECTS
Photosensitizing effects of 8-methoxypsoralen on the skin of hairless mice. I. Formation of interstrand cross-links in epidermal DNA (UV radiation), 2:42083
PUBLIC UTILITIES/COMPARATIVE EVALUATIONS
Changes in an electric utility's fuel base, 2:41653
PUBLIC UTILITIES/DATA PROCESSING
Using electronic data processing equipment for complotting supply grids, 2:41290
PUBLIC UTILITIES/ENERGY SHORTAGES
Changes in an electric utility's fuel base, 2:41653
Impact of natural gas curtailments on electric utility plants. Volume I. Text, 2:41033 (PB-258 329)
Impact of natural gas curtailments on electric utility plants. Volume II. Schedules, 2:41035 (PB-258330)
PUBLIC UTILITIES/FINANCING
Economic and financial impacts of federal air and water pollution controls on the electric utility industry. Final technical report, 2:41652 (PB-254308)
PUBLIC UTILITIES/FUEL ECONOMY
Changes in an electric utility's fuel base, 2:41653
PUBLIC UTILITIES/LOAD MANAGEMENT
Changes in an electric utility's fuel base, 2:41653
PUBLIC UTILITIES/MANAGEMENT
Minutes of and commentary on conference on utility load management held in Brussels on November 12-13, 1974 under the auspices of the NATO Committee on challenges of modern society, 2:41246 (PB-254297)
PUBLIC UTILITIES/PLANNING
Using electronic data processing equipment for complotting supply grids, 2:41290
PUBLIC UTILITIES/UNDERGROUND
Utilities for underground structures, 2:41590 (NSF-RA-760006)
PULSE COLUMNS
See EXTRACTION COLUMNS
PULSED D-T REACTORS/SPECIFICATIONS
Fusion reactor and operating process (Patent), 2:42280
PULSED MHD GENERATORS/RESEARCH PROGRAMS
Pulsed magnetohydrodynamic program. Final report 2 Jan 72-31 Mar 76, 2:41658 (AD-A-028323)
PULSED MHD GENERATORS/TEST FACILITIES
Research program in magnetogasdynamics utilizing hypervelocity coaxial plasma generators. Final report, 2:41660 (N-76-25019)
PUMPED STORAGE/TECHNOLOGY ASSESSMENT
Underground pumped storage research priorities. Technical planning study, 2:41558 (PB-254413)
PUMPED STORAGE POWER PLANTS
Waldeck II underground pumped-storage station, 2:41563
PUMPED STORAGE POWER PLANTS/CONSTRUCTION
Waldeck II underground pumped-storage station, 2:41559
PUMPED STORAGE POWER PLANTS/ELECTRICAL EQUIPMENT
Waldeck II underground pumped-storage station, 2:41559
PUMPED STORAGE POWER PLANTS/OPERATION
Pressure pulsations and spiral vibration when ventilating storage pumps, 2:41562
PUMPED STORAGE POWER PLANTS/PLANNING
Dinorwic power station, 2:41564
PUMPED STORAGE POWER PLANTS/REPAIR
Reconstruction of the pump storage station Bleiloch, East Germany, with simultaneous output increase, 2:41561
PUMPED STORAGE POWER PLANTS/START-UP
Cascade start-up of generator-motors at pumped storage hydroelectric plants, 2:41560
PUMPED STORAGE POWER PLANTS/WATER HAMMER
Analysis of total pump-turbine system including pipelines, 2:41177
PUMPED STORAGE POWER PLANTS/WATER RESOURCES
Dickey-Lincoln School Lakes hydrothermal model study; hydraulic laboratory investigation. Final report, Jul 1975-Jun 1976, 2:41557 (AD-A-034538)
PUMPS
See also SOLAR WATER PUMPS
TURBOMACHINERY
PUMPS/DESIGN
Feed and condensate pumps in nuclear power stations (BWR; PWR), 2:41322 (SIGLUT-P-719)
PUMPS/PERFORMANCE
Prediction of pump differential pressure for two-phase/two-component compressible flow (PWR), 2:41344
PUMPS/SEISMIC EFFECTS
Seismic analysis of vertical pumps enclosed in liquid filled containers (Reactor cooling systems), 2:41540
PUREX PROCESS/TESTING
First experiments on the reprocessing of fast reactor fuels in France, 2:41092 (CEA-CONF-3683)
PVC
(Polyvinyl chloride.)
PVC/CHEMICAL RADIATION EFFECTS
Viscosity effects in the radiation-induced grafting of vinyl monomers on polyvinylchloride films. Technical report, 2:41878 (AD-A-026822)
PWR TYPE REACTORS
See also BIBLIS-A REACTOR
CONNECTICUT YANKEE REACTOR
KOZLODUY-1 REACTOR
KOZLODUY-2 REACTOR
OBRIGHEIM REACTOR
STADE REACTOR
THREE MILE ISLAND-1 REACTOR
THREE MILE ISLAND-2 REACTOR
TIHANGE REACTOR
WWER TYPE REACTORS
PWR TYPE REACTORS/AUXILIARY WATER SYSTEMS
Feed and condensate pumps in nuclear power stations, 2:41322 (SIGLUT-P-719)
PWR TYPE REACTORS/BLOWDOWN
Effects of modeling variations on RELAP4. predictions of Standard Problem Five, 2:41544
PWR TYPE REACTORS/CONTROL ROD DRIVES
Fault tolerant, multiplexed control rod position detection and indication system for nuclear power plants, 2:41349
Magnetic jack control rod drives, 2:41491
PWR TYPE REACTORS/CORE FLOODING SYSTEMS
Prediction of reflood heat transfer with standard loop programs, 2:41553

PWR TYPE REACTORS/CORROSION
Importance of phosphate in the system iron/water. II. The chemistry of the system, 2:41817
PWR TYPE REACTORS/DESIGN
Medium-size nuclear plants, 2:41333 (IAEA-CN-36/568)
PWR TYPE REACTORS/ECCS
Literature search on slip and entrainment in a reactor cooling channel, 2:41531 (IKE-2-33)
PWR TYPE REACTORS/ECONOMICS
Arguments for the installation of small LWR nuclear power plants in developing countries, 2:41315 (IAEA-CN-36/89)
PWR TYPE REACTORS/FUEL CANS
Irradiation temperature memorization bt retention of krypton-85. Application to the temperature determination for the internal cladding surface of fuel elements in PWR, 2:41327 (CEA-R-4798)
PWR TYPE REACTORS/FUEL CYCLE
PWR and BWR light water reactor systems in the USA and their fuel cycle, 2:41319 (IAEA-CN-36/566)
PWR TYPE REACTORS/FUEL ELEMENT FAILURE
Experimental investigations of the power ramp failure propensity of LWR fuel, 2:41520 (IAEA-CN-36/279)
PWR TYPE REACTORS/FUEL ELEMENTS
Fuel performance in Babcock and Wilcox pressurized water reactors, 2:41346
Fuel reliability in light water reactors, experience and assessment for the future, 2:41316 (IAEA-CN-36/474)
Italian progress on LWR fuel design, manufacturing, testing and management, 2:41331 (IAEA-CN-36/310)
Performance and reliability of LWR fuel, 2:41317 (IAEA-CN-36/475)
Radiochemical evaluation of Babcock and Wilcox's commercial pressurized water reactor fuel performance, 2:41347
Work carried out in France on the design, manufacture, handling and development of nuclear fuel, 2:41334 (IAEA-CN-36/569)
PWR TYPE REACTORS/LOOSE PARTS MONITORING
Noise diagnostics for safety assessment. Quarterly progress report for October-December 1976, 2:41321 (ORNL/NUREG/TM-97)
PWR TYPE REACTORS/LOSS OF COOLANT
Analysis of loss of coolant accidents, 2:41515 (IAEA-CN-36/127)
Analysis of critical heat flux in flow reversal transients, 2:41545
PWR TYPE REACTORS/MATHEMATICAL MODELS
Analysis of critical heat flux in flow reversal transients, 2:41545
PWR TYPE REACTORS/MELTDOWN
Properties of light water reactor core melts, 2:41555
PWR TYPE REACTORS/PLUTONIUM RECYCLE
Experience with Pu-recycle fuel for large light water reactors in the Federal Republic of Germany, 2:41318 (IAEA-CN-36/558)
Pu utilization in fast-breeder and in light-water reactors in Italy, 2:41320 (IAEA-CN-36/577)
PWR TYPE REACTORS/PRESSURE VESSELS
Development of an integrated prestressed concrete vessel for water cooled reactors, 2:41324
Prestressed concrete pressure vessel with hot liner for PWR nuclear reactors, 2:41339
Study of radiation dosage to structural components in nuclear reactors. Final report, 2:41536 (PB-257567)
PWR TYPE REACTORS/PRIMARY COOLANT CIRCUITS
How nuclear welding differs from other kinds, 2:41330 (CS-INIS-3)
Summary on experimental methods for statistical transient analysis of two-phase gas-liquid flow, 2:41312 (ANL-76-75)
Tritium formation and elimination in light-water electronuclear plants, 2:41497 (IAEA-CN-36/238)
PWR TYPE REACTORS/PUMPS
Prediction of pump differential pressure for two-phase/two-component compressible flow, 2:41344
PWR TYPE REACTORS/RADIATION HEATING
Evaluation of uncertainties in the gamma-ray heating analysis of a PWR, 2:41329 (CONF-770401-4)
Three-dimensional synthesis approach to reactor internal gamma-ray heating, 2:41328 (CONF-770401-3)
PWR TYPE REACTORS/RADIOACTIVE WASTE PROCESSING
Role of volume reduction processes in LWR radwaste treatment, 2:41326
PWR TYPE REACTORS/REACTOR CORES
Representation of the light-water reflectors by boundary conditions, 2:41340
PWR TYPE REACTORS/REACTOR INTERNALS
Study of radiation dosage to structural components in nuclear reactors. Final report, 2:41536 (PB-257567)
PWR TYPE REACTORS/REACTOR KINETICS
Nonlinear dynamics of a pressurized water reactor core, 2:41341
PWR TYPE REACTORS/REACTOR OPERATION
PWR and BWR light water reactor systems in the USA and their fuel cycle, 2:41319 (IAEA-CN-36/566)
Safety aspects and operating experience of LWR plants in Japan, 2:41526 (IAEA-CN-36/544)
PWR TYPE REACTORS/REACTOR PROTECTION SYSTEMS
Design of KWU LWR safety systems, 2:41516 (IAEA-CN-36/132)
PWR TYPE REACTORS/REACTOR SAFETY
LWR safety research in the Federal Republic of Germany, 2:41525 (IAEA-CN-36/541)
Safety aspects and operating experience of LWR plants in Japan, 2:41526 (IAEA-CN-36/544)
Summary of LWR safety research in the USA, 2:41530 (IAEA-CN-36/584)
PWR TYPE REACTORS/SAFETY ENGINEERING
Safety considerations of PWR's, 2:41524 (IAEA-CN-36/512)
Some problems of the safety of PWR nuclear power plants viewed from the technical standpoint, 2:41523 (IAEA-CN-36/467)
PWR TYPE REACTORS/SECONDARY COOLANT CIRCUITS
PWR secondary system chemistry during air and cooling water in leakage, 2:41345
PWR TYPE REACTORS/STEAM GENERATORS
Functional performance of a two-tube helically-coiled once-through steam generator, 2:41342
Importance of phosphate in the system iron/water. II. The chemistry of the system, 2:41817
Modeling the effect of inventory loss on steam generator heat transfer, 2:41343
PYRENE/HYDROCRACKING
Hydrocracking of polynuclear aromatic hydrocarbons over silica-alumina based dual functional catalysts, 2:40953
PYRIDINES/MOLECULAR STRUCTURE
Boundary lubricity studies: structure-activity correlations in alkylpyridines, 2:41002
PYRITE/FLOTATION
Flotation of pyrite from coal: pilot plant study, 2:40741
PYRITE/OXIDATION
Bacterial oxidation in upgrading pyritic coals (Surface oxidation of pyrite by Thiobacillus-ferrooxidans), 2:40740
PYRITE/REMOVAL
Agglomeration in coal preparation (Oil agglomeration), 2:40739
Bacterial oxidation in upgrading pyritic coals (Surface oxidation of pyrite by Thiobacillus-ferrooxidans), 2:40740
Chemical cleaning of coal, 2:40742
PYROLYTIC CARBON/SYNTHESIS
Kinetics of the formation of pyrocarbon from methane, 2:41168
2-PYRROLIDINECARBOXYLIC ACID
See PROLINE

Q

QUAD CITIES-1 REACTOR/REACTOR OPERATION
Annual operating report for 1976, 2:41430 (DOCKET-50254-1006)
QUAD CITIES-2 REACTOR/REACTOR OPERATION
Annual operating report for 1976, 2:41430 (DOCKET-50254-1006)
QUEBEC/PETROLEUM DEPOSITS
Drilling in the St Lawrence Lowlands of Quebec, 2:40920
QUINONES/CHEMICAL COMPOSITION
Oxidative-reductive transformations of the quinoid groups of humic acids, 2:41875
QUINONES/OXIDATION
Oxidative-reductive transformations of the quinoid groups of humic acids, 2:41875

R

RADIATION DETECTORS
See also BEAM MONITORS
LOW LEVEL COUNTERS
PROPORTIONAL COUNTERS
RADIOISOTOPE SCANNERS
SCINTILLATION COUNTERS
SEMICONDUCTOR DETECTORS
RADIATION DETECTORS/CALIBRATION
Development of an anthropomorphic phantom for the calibration of external detectors for the in vivo measurement of plutonium, 2:42114 (BNWL-2088)
Proceedings of the workshop on measurement of heavy elements in vivo, 2:42093 (BNWL-2088)
RADIATION DOSE DISTRIBUTIONS/EXTRAPOLATION
Need for collection of quantitative distribution data for dosimetry and metabolic modeling, 2:42084 (CONF-770101-2)

RADIATION HEATING/ACCURACY
Evaluation of uncertainties in the gamma-ray heating analysis of a PWR, 2:41329 (CONF-770401-4)
RADIATION HEATING/MATHEMATICAL MODELS
Three-dimensional synthesis approach to reactor internal gamma-ray heating (PWR), 2:41328 (CONF-770401-3)
RADIATION STREAMING/MATHEMATICAL MODELS
Spatial channel theory: A technique for determining the directional flow of radiation through reactor systems, 2:41468 (CONF-770401-13)
RADIOACTIVE AEROSOLS/RADIOACTIVITY TRANSPORT
LMFBR Aerosol Release and Transport Program. Quarterly progress report for October-December 1976, 2:41533 (ORNL/NUREG/TM-90)
RADIOACTIVE AEROSOLS/SAMPLE PREPARATION
Secondary aerosols from power plant effluents: delivery and in vivo detection systems (Tissue distribution of inhaled radioisotope-labelled $(NH_4)_2SO_4$ and NH_4NO_3 aerosols in monkeys), 2:42124 (UCD-472-123)
RADIOACTIVE BIOLOGICAL WASTES
See RADIOACTIVE WASTES
RADIOACTIVE EFFLUENTS
See also RADIOACTIVE WASTES
RADIOACTIVE EFFLUENTS/BIOLOGICAL EFFECTS
Laboratory technique for obtaining fathead minnow eggs for use in toxicity experiments, 2:42130
RADIOACTIVE EFFLUENTS/ENVIRONMENTAL TRANSPORT
Environmental monitoring at Argonne National Laboratory. Annual report for 1976, 2:41961 (ANL-77-13)
RADIOACTIVE EFFLUENTS/RADIATION MONITORING
Effluent and sanitary sewer monitors, 2:42013 (LA-6638-M)
Environmental monitoring at Argonne National Laboratory. Annual report for 1976, 2:41961 (ANL-77-13)
RADIOACTIVE PARTICULATES
See PARTICLES
RADIOACTIVE WASTE DISPOSAL
Options for the disposal of high-level radioactive waste, 2:41136 (IAEA-CN-36/67)
RADIOACTIVE WASTE DISPOSAL/MARINE DISPOSAL
Evaluation of the limits of radioactive waste disposal into water systems of international importance, 2:41140 (IAEA-CN-36/346)
Seabed disposal program: geochemical and sedimentological studies of North Pacific sediments. Progress report, January 1, 1976-December 31, 1976, 2:41135 (COO-2689-6)
RADIOACTIVE WASTE DISPOSAL/SALT DEPOSITS
Statement of C.D. Zerby before the California Energy Resources Conservation and Development Commission, Sacramento, California, March 21, 1977, 2:41143 (Y/OWI/TM-22)
RADIOACTIVE WASTE DISPOSAL/UNDERGROUND DISPOSAL
Radioactive waste disposal in geological formations, 2:41138 (IAEA-CN-36/313)
Review of Dutch geologic waste disposal programme, 2:41137 (IAEA-CN-36/289)
Review of state licenses for disposal of low-level radioactive waste by shallow land burial. Technical note, 2:41141 (PB-258259)
Scientific prerequisites and practice for using deep water-bearing horizons for disposal of liquid radioactive wastes, 2:41139 (IAEA-CN-36/345)
RADIOACTIVE WASTE MANAGEMENT
See also RADIOACTIVE WASTE STORAGE
Development of radioactive waste management at Japan Atomic Energy Research Institute, 2:41115 (IAEA-CN-36/156)
Goals, objectives and criteria for the management of nuclear wastes: rethinking the problem, 2:41127 (IAEA-CN-36/511)
Handling of waste at Swedish nuclear power plants, 2:41121 (IAEA-CN-36/282)
Management and control of radioactive wastes from uranium-milling operations, 2:41125 (IAEA-CN-36/479)
Management of high level radioactive waste, 2:41119 (IAEA-CN-36/226)
Management of radioactive wastes from nuclear fuels and power plants in Canada, 2:41116 (IAEA-CN-36/178)
Management of high level waste, 2:41112 (IAEA-CN-36/15)
Management of radioactive waste and plutonium in the Swedish perspective, 2:41128 (IAEA-CN-36/554)
Management of radioactive wastes: an overview of the Indian programme, 2:41123 (IAEA-CN-36/388)
Radioactive waste management in Belgium, 2:41117 (IAEA-CN-36/187)
Spanish program on disposal of radioactive wastes, 2:41118 (IAEA-CN-36/206)
Waste management in the Federal Republic of Germany: a survey of policy and research and development, 2:41114 (IAEA-CN-36/98)
Waste management implications of irradiated nuclear fuel storage, 2:41104 (IAEA-CN-36/23)
RADIOACTIVE WASTE MANAGEMENT/ENVIRONMENTAL EFFECTS
Assessment methodology of environmental risks associated with radioactive waste management, 2:41113 (IAEA-CN-36/28)
RADIOACTIVE WASTE MANAGEMENT/INTERNATIONAL COOPERATION
Present trends in radioactive waste management policies in OECD countries and related international co-operative efforts, 2:41126 (IAEA-CN-36/491)
RADIOACTIVE WASTE MANAGEMENT/RADIATION PROTECTION
Safety and radiation protection aspects of the management of radioactive wastes of high level activity, 2:41120 (IAEA-CN-36/231)
RADIOACTIVE WASTE PROCESSING/COST
Role of volume reduction processes in LWR radwaste treatment, 2:41326
RADIOACTIVE WASTE PROCESSING/EVAPORATORS
Thin-film evaporators for processing BWR liquid radwaste, 2:41325
RADIOACTIVE WASTE PROCESSING/FILTRATION
Discharge into the atmosphere of volatile fission products from nuclear power stations and fuel reprocessing plants and the perspectives of their retention, 2:41132 (IAEA-CN-36/317)
RADIOACTIVE WASTE PROCESSING/SOLIDIFICATION
Advanced waste forms research and development. Comprehensive progress report, 2:41130 (COO-2510-12)
Correlation of composition, structure characteristics and properties for high level waste solidification products, 2:41134 (IAEA-CN-36/470)
Development of methods for solidification and disposal of fuel cycle radioactive wastes, 2:41122 (IAEA-CN-36/350)
Evaluation of solidification matrices proposed for nuclear power plant radwaste, 2:41131 (IAEA-CN-36/186)
RADIOACTIVE WASTE PROCESSING/TRANSMUTATION
Nuclear transmutation of actinides other than fuel as a radioactive waste management scheme, 2:41133 (IAEA-CN-36/366)
Transmutation of strontium-90 and cesium-137 in a high-flux fast reactor with a thermalized central region, 2:41460
RADIOACTIVE WASTE STORAGE/CHARGES
Storage fee analysis for a nuclear waste terminal storage facility. Final report, 2:41142 (Y/OWI/SUB-76/16503)
RADIOACTIVE WASTE STORAGE/SITE SELECTION
Radioactive waste management: model analysis of a proposed site, 2:41129
RADIOACTIVE WASTE STORAGE/SUBSURFACE STRUCTURES
Radioactive waste management: model analysis of a proposed site, 2:41129
RADIOACTIVE WASTES
See also OFF-GAS SYSTEMS
RADIOACTIVE EFFLUENTS
RADIOACTIVE WASTES/CHEMICAL ANALYSIS
Laser Raman spectrometric determination of oxy-anions in nuclear waste materials, 2:41868 (ARH-SA-279)
RADIOIMMUNOASSAY/CALIBRATION
Robust calibration. Technical report, 2:42059 (AD-A-031114)
RADIOISOTOPE BATTERIES/ENVIRONMENTAL IMPACT STATEMENTS
Generic environmental statement on routine use of plutonium-powered cardiac pacemakers. Final report, 2:42138 (PB-255197)
RADIOISOTOPE HEAT SOURCES/CONTAINERS
Fracture behavior of a Pt-30% Rh-8% W alloy between room temperature and 1300°c, 2:41156
RADIOISOTOPE HEAT SOURCES/RESEARCH PROGRAMS
Quarterly report on the strontium heat source development program and the beneficial isotopes utilization program, Division of Nuclear Research and Application for October-December 1976 (WESF capsules), 2:41155 (BNWL-1845-31)
RADIOISOTOPE KINETICS
See RADIONUCLIDE KINETICS
RADIOISOTOPE SCANNERS/CALIBRATION
Calibration for plutonium-238 lung counting at Mound Laboratory, 2:42101 (BNWL-2088)
RADIOLOGY/DOSIMETRY
Radiological physics and dosimetry research with a small positive ion accelerator, 2:42076 (BNWL-SA-5966)
RADIONUCLIDE KINETICS
(In living organisms.)
RADIONUCLIDE KINETICS/ERRORS
Determination of heavy elements in humans, 2:42099 (BNWL-2088)
RADIONUCLIDE KINETICS/MEASURING METHODS
Determination of heavy elements in humans, 2:42099 (BNWL-2088)
RADIOWAVE RADIATION
See also SOLAR RADIOWAVE RADIATION

RADIOWAVE RADIATION/BIOLOGICAL EFFECTS
Quadrennial report of the division of biological effects, 1971-1974, 2:42078 (PB-258436)
RADIOWAVE RADIATION/DOSIMETRY
Radiofrequency radiation dosimetry handbook. Interim report 1 Jan-31 Jul 76, 2:42135 (AD-A-030874)
RADIUM 226/BIOLOGICAL RADIATION EFFECTS
Annual report, fiscal year 1976, 2:42118 (UCD-472-123)
Clinical case load for radionuclide-treated beagles, calendar year 1975, 2:42088 (UCD-472-123)
RADIUM 226/TISSUE DISTRIBUTION
Canine bone dynamics, 2:42090 (UCD-472-123)
RADON/RADIATION MONITORING
Report of ambient outdoor radon and indoor radon progeny concentrations during November 1975 at selected locations in the grants mineral belt, New Mexico. Final technical note, 2:41996 (PB-258257)
RAIL TRANSPORT/ENERGY ACCOUNTING
Energy embodied in goods, 2:41654 (ORAU/IEA(M)-77-6)
RAIL TRANSPORT/SAFETY ENGINEERING
Development of protective canopy concepts for underground rail haulage equipment. Research report, 2:40873 (PB-254504)
RAILWAYS
See also ELECTRIC RAILWAYS
RAILWAYS/PLANNING
Energy savings resulting from modal shifts to Corridorrail, 2:41739 (PB-257409)
RANKINE CYCLE ENGINES/DESIGN
Hybrid-engine (Patent), 2:41734
Steam piston engine, 2:41727
RANKINE CYCLE ENGINES/STEAM GENERATION
Steam piston engine, 2:41727
RANKINE CYCLE ENGINES/TECHNOLOGY ASSESSMENT
Assessment of the technology of Rankine engines for automobiles, 2:41726 (ERDA-77-54)
RANKINE CYCLE POWER SYSTEMS
Development of a solar-powered residential air conditioner (Rankine cycle power systems), 2:41208 (N-76-30656)
Development of a solar-powered residential air conditioner: screening analysis (RAnkine cycle power systems), 2:41209 (N-76-30659)
Development of a solar-powered residential air conditioner: system optimization preliminary specification (Rankine cycle power system), 2:41210 (N-76-30660)
RANKINE CYCLE POWER SYSTEMS/ECONOMICS
Development of a solar-powered residential air conditioner: economic analysis (Rankine cycle power system), 2:41206 (N-76-30653)
RANKINE CYCLE POWER SYSTEMS/MATHEMATICAL MODELS
Simulation and operation of a solar powered organic Rankine cycle turbine (32 kW), 2:41223
RAPID TRANSIT SYSTEMS
See also ELECTRIC RAILWAYS
RAPID TRANSIT SYSTEMS/DESIGN
Procedure for optimizing rapid transit car design. Project report, 2:41729 (PB-255048)
RAPID TRANSIT SYSTEMS/SIMULATION
Station simulation studies for personalized rapid transit urban development, 2:41705
RAPID TRANSIT SYSTEMS/TUNNELS
Subsurface exploration methods for soft ground rapid transit tunnels. Volume II: Appendixes A-F. Final report Jun 73-Jun 75, 2:41740 (PB-258344)
RAPSODIE REACTOR/FUEL CYCLE
Rapsodie: A closed fuel cycle, 2:41393 (IAEA-CN-36/266)
RARE EARTH ALLOYS/MAGNETOSTRICTION
Rare Earth-transition metal magnetostrictive materials. Progress report, 2:41795 (AD-A-030791)
RAYLEIGH-TAYLOR INSTABILITY
Frictional effects with neutrals and Rayleigh-Taylor instability of a compressible Hall plasma, 2:42252
RDF
See REFUSE DERIVED FUELS
REACTOR ACCIDENTS
See also FUEL ELEMENT FAILURE
LOSS OF COOLANT
MELTDOWN
REACTOR CORE DISRUPTION
REACTOR ACCIDENTS/SIMULATION
Evaluation of local accidents in LMFBR, 2:41527 (IAEA-CN-36/551)
REACTOR COMPONENTS
See also BREEDING BLANKETS
CONTROL ELEMENTS
CONTROL ROD DRIVES
FUEL ELEMENTS
REACTOR COOLING SYSTEMS
REACTOR CORES
REACTOR COMPONENTS/PERFORMANCE TESTING
Liquid Metal Engineering Center (LMEC). Annual technical progress report, January-December 1976 (LMFBR sodium component and instrumentation testing), 2:41405 (LMEC-77-1)
REACTOR COMPONENTS/STRESS ANALYSIS
Assessment of non-linear analysis finite element program (NONSAP) for inelastic analysis, 2:41465 (BNL-NUREG-50615)
REACTOR CONTROL RODS
See CONTROL ELEMENTS
REACTOR CONTROL SYSTEMS
(The processes and operations ensuring the control and safe running of a nuclear reactor.)
Comparison of two adaptive identification methods for monitoring and diagnosis of an experimental nuclear reactor, 2:42335
REACTOR CONTROL THEORY
See REACTOR KINETICS
REACTOR COOLING SYSTEMS
See also PRIMARY COOLANT CIRCUITS
RHR SYSTEMS
SECONDARY COOLANT CIRCUITS
REACTOR COOLING SYSTEMS/FLUID FLOW
Two-dimensional transient flow analysis of a pipe-elbow loop by finite-differences, 2:41459
REACTOR COOLING SYSTEMS/HYDROGEN METERS
Sodium contamination measurement with plugging meter and hydrogen leak detection system, 2:41414
REACTOR COOLING SYSTEMS/PIPE FITTINGS
Three-dimensional stress analyses of mitered elbows, 2:41473
REACTOR COOLING SYSTEMS/PUMPS
Seismic analysis of vertical pumps enclosed in liquid filled containers, 2:41540
REACTOR COOLING SYSTEMS/RELIEF VALVES
Dynamic load amplification factors for safety valve headers, 2:41478
REACTOR COOLING SYSTEMS/TWO-PHASE FLOW
A review of the rational approach to two-phase flow modeling. Topical report, 2:41457 (PB-255548)
REACTOR COOLING SYSTEMS/WATER HAMMER
Effects of the steam chest on steamhammer analysis for nuclear piping systems, 2:41476
REACTOR CORE DISRUPTION
LMFBR safety. 3. Review of current issues and bibliography of literature (1972-1974), 2:41532 (ORNL/NUREG/NSIC-131)
REACTOR CORE DISRUPTION/FISSION PRODUCT RELEASE
LMFBR Aerosol Release and Transport Program. Quarterly progress report for October-December 1976, 2:41533 (ORNL/NUREG/TM-90)
REACTOR CORE DISRUPTION/FUEL-COOLANT INTERACTIONS
Stability of a submerged frozen crust (LMFBR), 2:41552
REACTOR CORE DISRUPTION/HYDRODYNAMICS
Potential for penetration of a hot vapor jet into a subcooled liquid (LMFBR), 2:41551
REACTOR CORE RESTRAINTS/RESEARCH PROGRAMS
Core restraint development. Quarterly progress report for period ending November 30, 1976 (LMFBR), 2:41407 (WARD-CR-3045-15)
REACTOR CORES
Gas-cooled fast breeder reactor. Quarterly progress report, November 1, 1976-January 31, 1977, 2:41384 (GA-A-14240)
REACTOR CORES/DESIGN
Advanced LMFBR core design. Fifth quarterly report, July-September 1976, 2:41387 (GEAP-14078-5)
REACTOR CORES/ENGINEERING
Core engineering sixtieth quarterly report, August-October 1976 (LMFBR; FFTF), 2:41385 (GEAP-10028-60)
REACTOR CORES/HYDRAULICS
'STEALTH' a Lagrange explicit finite-difference code for solids structural, and thermohydraulic analysis. Technical report (Nuclear reactor design), 2:41456 (PB-255405)
REACTOR CORES/NEUTRON REFLECTORS
Representation of the light-water reflectors by boundary conditions (PWR), 2:41340
REACTOR CORES/THERMODYNAMICS
'STEALTH' a Lagrange explicit finite-difference code for solids structural, and thermohydraulic analysis. Technical report (Nuclear reactor design), 2:41456 (PB-255405)
REACTOR FUEL ELEMENTS
See FUEL ELEMENTS
REACTOR INSTRUMENTATION
See also LOOSE PARTS MONITORING
REACTOR INSTRUMENTATION/ELECTRIC CABLES
Temperature and voltage tests on MgO insulated coaxial cables (LMFBR), 2:41389 (HEDL-TME-76-66)

REACTOR INSTRUMENTATION/PERFORMANCE TESTING
Liquid Metal Engineering Center (LMEC). Annual technical progress report, January-December 1976 (LMFBR sodium component and instrumentation testing), 2:41405 (LMEC-77-1)
REACTOR INTERNALS/RADIATION DOSES
Study of radiation dosage to structural components in nuclear reactors. Final report (BWR; PWR), 2:41536 (PB-257567)
REACTOR KINETICS/NONLINEAR PROBLEMS
Nonlinear dynamics of a pressurized water reactor core, 2:41341
REACTOR KINETICS/PULSED NEUTRON TECHNIQUES
Two-dimensional calculation of a pulse propagation experiment, 2:41463
REACTOR KINETICS/SENSITIVITY
Eigenvalue sensitivity study of a high temperature gas cooled reactor system, 2:41364
REACTOR KINETICS/TWO-DIMENSIONAL CALCULATIONS
Coarse-mesh correction of the finite difference method for neutron diffusion calculations (LMFBR), 2:41416
Two-dimensional calculation of a pulse propagation experiment, 2:41463
REACTOR LATTICES/NEUTRON TRANSPORT
Groupwise rebalancing technique for integral transport problems, 2:41462
REACTOR LICENSING
Licensee contractor and vendor inspection status report. Quarterly report, 2:41435 (PB-255418)
REACTOR MATERIALS
(See also specific materials.)
HTGR fuels and core development program. Quarterly progress report for the period ending February 28, 1977, 2:41355 (GA-A-14298)
REACTOR MATERIALS/CORROSION
Sea water corrosion. Volume 1. 1964-1975 (a bibliography with abstracts). Report for 1964-1975, 2:41815 (NTIS/PS-77/0052)
REACTOR MATERIALS/FRACTURE PROPERTIES
Determining fracture properties of reactor vessel forging materials, weldments, and bolting materials. Final report, 2:41783 (PB-257563)
REACTOR MATERIALS/PERFORMANCE TESTING
Liquid Metal Engineering Center (LMEC). Annual technical progress report, January-December 1976 (LMFBR sodium component and instrumentation testing), 2:41405 (LMEC-77-1)
REACTOR MATERIALS/RESEARCH PROGRAMS
Advanced gas cooled nuclear reactor materials evaluation and development program. Progress report, September 23, 1976-December 31, 1976, 2:41350 (COO-2975-3)
REACTOR MATERIALS/STRESS CORROSION
Caustic stress corrosion cracking (LMFBR), 2:41388 (HEDL-SA-1122)
REACTOR OPERATION
Millstone Nuclear Power Station, Unit 1. Annual operating report: 1 January-31 December 1976, 2:41429 (DOCKET-50245-956)
Quad-Cities Station, Units 1 and 2. Annual operating report for 1976, 2:41430 (DOCKET-50254-1006)
Recent U.S. reactor operating experience, 2:41309 (IAEA-CN-36/483)
Vermont Yankee Nuclear Power Station. Annual operating report: January-December 1976, 2:41431 (DOCKET-50271-917)
REACTOR PROTECTION SYSTEMS/DESIGN
Design of KWU LWR safety systems, 2:41516 (IAEA-CN-36/132)
Reactivity requirements and safety systems for heavy water reactors, 2:41522 (IAEA-CN-36/393)
Safety of heavy-water reactors, 2:41518 (IAEA-CN-36/181)
REACTOR PROTECTION SYSTEMS/FAILURE MODE ANALYSIS
Common mode failure analysis, 2:41539
REACTOR SAFETY
(Theoretical and experimental investigations of the behavior of reactor types and designs under various real or hypothetical accidents.)
BWR blowdown/emergency core cooling third quarterly progress report, July 1-September 30, 1976, 2:41511 (GEAP-21304-3)
European in-pile investigations on fast breeder reactor safety, 2:41519 (IAEA-CN-36/245)
Gas-cooled fast breeder reactor. Quarterly progress report, November 1, 1976-January 31, 1977, 2:41384 (GA-A-14240)
LWR safety research in the Federal Republic of Germany, 2:41525 (IAEA-CN-36/541)
REACTOR SAFETY/BIBLIOGRAPHIES
LMFBR safety. 3. Review of current issues and bibliography of literature (1972-1974), 2:41532 (ORNL/NUREG/NSIC-131)
REACTOR SAFETY/RESEARCH PROGRAMS
Gas-cooled fast breeder reactor accident initiation and progression analysis. Progress report, July 1, 1975-June 30, 1976, 2:41510 (GA-A-14079)
Summary of LWR safety research in the USA, 2:41530 (IAEA-CN-36/584)
REACTORS
See also BREEDER REACTORS
GAS COOLED REACTORS
MOLTEN SALT REACTORS
POWER REACTORS
TRANSPORTABLE REACTORS
WATER COOLED REACTORS
REACTORS/PRESSURE VESSELS
Assessment of non-linear analysis finite element program (NONSAP) for inelastic analysis, 2:41465 (BNL-NUREG-50615)
RECORDS RETRIEVAL
See INFORMATION RETRIEVAL
RECYCLE (FUEL)
See FUEL CYCLE
RECYCLING/REVIEWS
Recycling trends in the United States: a review. Information circular 1976, 2:41692 (PB-254222)
REFERENCE THETA PINCH REACTOR/REVIEWS
Experiments towards a toroidal-theta-pinch fusion reactor, 2:42283
REFLECTORS (NEUTRON)
See NEUTRON REFLECTORS
REFUELING WATER SYSTEMS
See AUXILIARY WATER SYSTEMS
REFUSE
See SOLID WASTES
REFUSE DERIVED FUELS
See also MUNICIPAL WASTES
SOLID WASTES
REFUSE DERIVED FUELS/COMBUSTION
Technical evaluation study: solid waste as a fuel at Ft. Bragg, N. C. Final report, 2:41174 (AD-A-034416)
REFUSE DERIVED FUELS/TECHNOLOGY ASSESSMENT
Markets and technology for recovering energy from solid waste, 2:41259 (PB-253326)
REINFORCED CONCRETE/FRACTURE PROPERTIES
Cracking of reinforced concrete heated cylindric containers in the presence of thrusting slabs, 2:41482
RELATIVISTIC PLASMA/MAGNETOHYDRODYNAMICS
Relativistic magnetohydrodynamics of an accelerating plasma, 2:42240
RELIEF VALVES/STRESS ANALYSIS
Dynamic load amplification factors for safety valve headers, 2:41478
RESERVOIR ROCK/MATHEMATICAL MODELS
Methodology of reservoir rocks separation in the miocene profile of the carpathian foothills using multiple regression analysis, 2:40924
Our nation's crude oil and natural gas recoveries may be increased by numerical simulation, 2:40917
RESERVOIR ROCK/PERMEABILITY
Surface directional permeability analyzer, 2:40784 (MERC/SP-76/3)
RESERVOIR ROCK/PLUGGING
Asphaltene flocculation during solvent stimulation of heavy oils, 2:40941
RESIDENTIAL SECTOR/POWER DEMAND
An energy demand model for the Swedish residential heating sector, 2:41675 (PB-256202)
RESIDENTIAL SECTOR/SOLAR SPACE HEATING
An investigation of the acceptance of solar heating and cooling in the housing industry in New Mexico. Final technical report, 1 Aug 1975-31 Jul 1976, 2:41205 (N-76-28652)
RESIDENTIAL SECTOR/SPACE HEATING
An energy demand model for the Swedish residential heating sector, 2:41675 (PB-256202)
RESIDUAL FUELS/ACTIVATION ANALYSIS
Mode of occurrence of trace elements in petroleum and relationship to oil-spill identification methods, 2:41027
RESIDUAL FUELS/CHROMATOGRAPHY
Compound type separation and characterization studies for a 370° to 535°C boiling distillate of Gach Saran, Iran, crude oil, 2:41021
RESIDUAL FUELS/DESULFURIZATION
Pilot plant proves Resid process, 2:40958
RESIDUAL FUELS/GAS CHROMATOGRAPHY
Characterization and identification of spilled residual fuel oils by gas chromatography and infrared spectrophotmetry, 2:40993
RESIDUAL FUELS/INFRARED SPECTRA
Characterization of heavy residual fuel oils and asphalts by infrared spectrophotometry using statistical discriminant function analysis, 2:40994
RESIDUAL FUELS/SPECTROPHOTOMETRY
Characterization of heavy residual fuel oils and asphalts by infrared spectrophotometry using statistical discriminant function analysis, 2:40994

RESIDUAL FUELS/SPECTROSCOPY
Compound type separation and characterization studies for a 370° to 535°C boiling distillate of Gach Saran, Iran, crude oil, 2:41021
RESIDUAL STRESSES/MEASURING METHODS
Measurement of residual stresses by the hole-drilling method, 2:41880 (SAND-77-8006)
RESIDUES
See also ASHES
RESIDUES/CARBONIZATION
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
RESIDUES/LEACHING
Preliminary laboratory and modeling studies on the environmental impact of 'in-situ' coal gasification, 2:40753 (MERC/SP-76/3)
RESIDUES (RADIOACTIVE)
See RADIOACTIVE WASTES
RESINS/CHEMICAL COMPOSITION
Extraction resins of brown coals, 2:40805
RESINS/MECHANICAL PROPERTIES
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)
RESINS/PHYSICAL PROPERTIES
Extraction resins of brown coals, 2:40805
RESINS/THERMAL CONDUCTIVITY
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)
RESISTIVITY LOGGING/DATA ANALYSIS
Comparison of sounding results and their interpretation in the absence of borehole control, 2:42143
Recent developments in the direct interpretation of resistivity soundings, 2:41939
RESOURCE CONSERVATION/LEGISLATION
Resource recovery and source reduction. First report to Congress, 2:41693 (PB-255139)
Resource recovery and waste reduction. Third report to Congress, 2:41694 (PB-255141)
RESPIRATORY SYSTEM
See also LUNGS
RESPIRATORY SYSTEM/NEOPLASMS
Review of the carcinogenicities of nickel, chromium, and arsenic compounds in man and animals, 2:42132
RETINA/MEMBRANES
Neutron diffraction studies of oriented retinal rods, 2:42022 (BNL-50453)
RETINA/PROTEINS
Neutron diffraction analysis of the structure of retinal photoreceptor membranes and rhodopsin, 2:42018 (BNL-50453)
RHENIUM ALLOYS/PHONONS
Phonon anomalies in transition metals, alloys, and compounds, 2:41809
RHENIUM ALLOYS/SUPERCONDUCTIVITY
Phonon anomalies in transition metals, alloys, and compounds, 2:41809
RHENIUM CARBIDES/PHASE DIAGRAMS
Some constitutional studies on uranium-carbon- and plutonium-carbon-rhenium and technetium systems, 2:41827
RHODIUM ALLOYS/CRYSTAL STRUCTURE
Crystal structure of the compounds Pu_6X_4 (X=Rh, Ir), 2:41766
RHODIUM ALLOYS/DE HAAS-VAN ALPHEN EFFECT
de Haas-van Alphen effect in URh_3 and UIr_3, 2:41762
RHODIUM ALLOYS/ELECTRONIC STRUCTURE
Electronic energy band structure of actinide metals and intermetallics, 2:41772
RHODIUM ALLOYS/FRACTURE PROPERTIES
Fracture behavior of a Pt-30% Rh-8% W alloy between room temperature and 1300°c, 2:41156
RHODIUM ALLOYS/HYPERFINE STRUCTURE
Hyperfine interactions in Np Pdsub(3-x)Rhsub(x), 2:41770
RHR SYSTEMS
(Residual heat removal.)
RHR SYSTEMS/RELIABILITY
Reliability analysis of the decay heat removal system of a 1000-MW(e) gas-cooled fast breeder reactor, 2:41425
RIBONUCLEIC ACID
See RNA
RIBOSOMES/BINDING ENERGY
Nucleotide sequence of a viral RNA fragment that binds to eukaryotic ribosomes, 2:42032
RIBOSOMES/MOLECULAR BIOLOGY
Neutron scattering measurements with the label triangulation method on the 50 S subunit of E. coli ribosomes, 2:42027 (BNL-50453)
RIBOSOMES/NEUTRON DIFFRACTION
Protein pair distance determination in the 30 S ribosoma subunit of E. coli, 2:42026 (BNL-50453)
RICE/SOLAR DRYING
Solar energy applications in agriculture: potential, research needs, and adoption strategies, summary and recommendations, 2:41217 (PB-255928)
RICHLAND FFTF REACTOR
See FFTF REACTOR
RICHLAND NPR REACTOR
See N-REACTOR
RIEMANN WAVES
See SHOCK WAVES
RISER CRACKING
See COAL LIQUEFACTION
RNA
(Ribonucleic acid.)
RNA/BINDING ENERGY
Nucleotide sequence of a viral RNA fragment that binds to eukaryotic ribosomes, 2:42032
RNA/BIOSYNTHESIS
Studies of temperature sensitive mutants of bacteriophage Qβ, defective in both replication and translation, 2:42045
RNA/MOLECULAR STRUCTURE
Nucleotide sequence of a viral RNA fragment that binds to eukaryotic ribosomes, 2:42032
ROADS/BUILDING MATERIALS
Optimizing the use of materials and energy in transportation construction, 2:41683 (PB-253713)
Technology for using sulfate waste in highway construction. Final report, 2:40850 (PB-254815)
ROADS/ENVIRONMENTAL EFFECTS
Erosion and sediment control audiovisual training program instructor's workbook. Final report, 2:41999 (PB-258471)
ROADS/EROSION
Demonstration of coal mine haul road sediment control techniques. Final report, 2:40879 (PB-258304)
ROCK BURSTS/MONITORING
Mine surveying and rock bursts prevention at 'bergbau '76', 2:40895
ROCKS
See also RESERVOIR ROCK
ROCKS/PERMEABILITY
Hydrogeologic assessment of an underground coal gasification project site Grant District, Wettzel County, W. Va., 2:40855 (MERC/SP-76/3)
ROCKY FLATS PLANT/RADIATION MONITORING
Health and Safety Laboratory environmental quarterly, December 1, 1976-March 1, 1977, 2:42085 (HASL-318)
ROTARY ENGINES/DESIGN
Rotary piston combustion engine (Patent), 2:41724
ROUS SARCOMA VIRUS
See ONCOGENIC VIRUSES
RUBY LASERS/OPTICAL SYSTEMS
Array laser: a technique for the generation of ultra-high laser intensities, 2:41902 (LA-UR-75-2260)
RULISON EVENT
Gas quality and geochemical studies in gas-stimulation experiments, 2:41040
RUPTURE DISKS
See RELIEF VALVES
RURAL POPULATIONS/SOCIO-ECONOMIC FACTORS
A comparative case study of the impact of coal development on the way of life of people in the coal areas of eastern Montana and northeastern Wyoming. Final report, 2:40856 (PB-254924)
RUTHENIUM ALLOYS
See also RUTHENIUM BASE ALLOYS
RUTHENIUM ALLOYS/PHONONS
Phonon anomalies in transition metals, alloys, and compounds, 2:41809
RUTHENIUM ALLOYS/SUPERCONDUCTIVITY
Phonon anomalies in transition metals, alloys, and compounds, 2:41809
RUTHENIUM BASE ALLOYS/THERMODYNAMIC PROPERTIES
Thermodynamic properties of the binary Laves phase compounds of plutonium with the group VIIIa metals, 2:41797

S

SACCHAROSE/BIOLOGICAL EFFECTS
Slow phase hemolysis in hypotonic electrolyte solutions, 2:42028
SAFEGUARDS/OPTIMIZATION
Overall probability of detection in connection with the optimization of safeguards effort, 2:41146

SALT DEPOSITS/REVIEWS
List of Louisiana oil and gas fields and salt domes including the offshore areas showing code numbers and official abbreviations, 2:41646
SALTON SEA GEOTHERMAL FIELD/GEOTHERMAL GRADIENTS
On shallow-hole temperature measurements--a test study in the Salton Sea geothermal field, 2:41236 (PB-262643)
SAMARIUM/CHEMICAL REACTIONS
Determination of absolute photon yields in chemiluminescent reactions. Annual technical report, 3 Dec 1975-2 Dec 1976, 2:41872 (AD-A-034515)
SAMARIUM PERCHLORATES/OSMOSIS
Isopiestic determination of the activity coefficients of some aqueous rare earth electrolyte solutions at 25°C. II. The rare earth perchlorates, 2:41874
SAMARIUM PERCHLORATES/THERMODYNAMIC PROPERTIES
Heats of dilution of some aqueous rare earth electrolyte solutions at 25°C. I. Rare earth perchlorates, 2:41873
SARCOMAS/IMMUNE REACTIONS
Immunogenic and antigenic properties of a rat Moloney sarcoma, 2:42056
SATELLITES
See also MOON
SATELLITES/PLANNING
HEAO Block 2 study executive summary, 2:42159 (N-76-28123)
SATURN PLANET/PLANETARY MAGNETOSPHERES
Polar aurora in the magnetosphere, 2:42193 (N-76-27751)
SCANDIUM 46/COSMOCHEMISTRY
Cosmogenic radionuclides in stone meteorites, 2:42173 (N-76-25115)
SCHMEHAUSEN THTR REACTOR
See THTR-300 REACTOR
SCHNELLER NATRIUMGEKUEHLTER REAKTOR
See SNR-1 REACTOR
SCHOOL BUILDINGS/ENERGY CONSERVATION
Terraset Elementary School, Reston, Virginia (Underground, solar-heated), 2:41616 (NSF-RA-760006)
University of Minnesota book store (95% below grade level), 2:41614 (NSF-RA-760006)
SCHOOL BUILDINGS/UNDERGROUND
University of Houston student center, 2:41615 (NSF-RA-760006)
SCHOTTKY BARRIER DIODES
Theory of solid surfaces. Final scientific report 1 Oct 1972-30 Sep 1975, 2:42209 (AD-A-031022)
SCHOTTKY BARRIER DIODES/PHYSICAL RADIATION EFFECTS
Interface states in Schottky barrier diodes. Interim report, 2:41933 (AD-A-034425)
SCINTIGRAPHY
See SCINTISCANNING
SCINTILLATION COUNTERS
See also GAS SCINTILLATION DETECTORS
SOLID SCINTILLATION DETECTORS
SCINTILLATION COUNTERS/DESIGN
Optimum design of an intensity limited pinhole-scintillator, image converter camera model for simultaneous energy, spatial, and time resolution of soft x-rays. Final report, 15 Aug 1975-30 Jun 1976, 2:42223 (AD-A-034405)
SCINTILLATION COUNTERS/PERFORMANCE
Low fluxes of x rays. Final report (Interactions of high-energy protons with spacercraft materials and typical materials for scintillation detectors), 2:41936 (N-76-30279)
SCINTILLATION COUNTERS/PHYSICAL RADIATION EFFECTS
Low fluxes of x rays. Final report (Interactions of high-energy protons with spacercraft materials and typical materials for scintillation detectors), 2:41936 (N-76-30279)
SCINTISCANNING
Scintiphotos in the diagnosis of renal allograft malfunction, 2:42061
SCRUBBERS/COMPARATIVE EVALUATIONS
Utilization of low BTU gas from in-situ coal gasification for on-site power generation, 2:40773 (MERC/SP-76/3)
SCYLLAC DEVICES/REVIEWS
Experiments towards a toroidal-theta-pinch fusion reactor, 2:42283
SEA BED/TOPOGRAPHY
Geophysical and geochemical models of the Earth's shields and rift zones, 2:42140 (UCRL-52238)
SEAS
See also ATLANTIC OCEAN
PACIFIC OCEAN
SEAS/ECOLOGY
Decomposition in freshwater, 2:42004
SEAWATER/CORROSIVE EFFECTS
Sea water corrosion. Volume 1. 1964-1975 (a bibliography with abstracts). Report for 1964-1975, 2:41815 (NTIS/PS-77/0052)
SEAWATER/SAMPLING
Trace element geochemistry of the South Atlantic Bight. Progress report, June 1, 1976-May 31, 1977, 2:42147 (SRO-890-2)
SEBACEOUS GLANDS
See SKIN
SECONDARY COOLANT CIRCUITS/WATER CHEMISTRY
PWR secondary system chemistry during air and cooling water in leakage, 2:41345
SEDIMENTS/ISOTOPE DATING
Concentration of diatom frustules in Lake Michigan sediment cores (^{210}Pb, ^{137}Cs), 2:42005
SEISMIC WAVES/DATA TRANSMISSION
Alaska Peninsula telemetered seismic network. Annual report, 2:42141 (RLO-2229-TC-3)
SELENIUM/ACTIVATION ANALYSIS
Mode of occurrence of trace elements in petroleum and relationship to oil-spill identification methods, 2:41027
SELENIUM/X-RAY EMISSION ANALYSIS
Investigation of size-dependent concentration of trace elements in aerosols emitted from the oil-fired heating plants, 2:40986 (N-76-27720)
SEMICONDUCTOR DETECTORS
S^3 solid state proton experiment. Part II. Mean energy of a finite energy passband. Technical memo, 2:41930 (PB-257833)
SEMICONDUCTOR DEVICES
See also SEMICONDUCTOR LASERS
SEMICONDUCTOR DEVICES/PERFORMANCE TESTING
Preliminary evaluations of a high-purity germanium detector system for in vivo measurement of inhaled transuranium elements, 2:42113 (BNWL-2088)
SEMICONDUCTOR DEVICES/RADIATION HARDENING
Irradiate-anneal screening of total dose effects in semiconductor devices, 2:41935 (N-76-28223)
SEMICONDUCTOR LASERS/FREQUENCY MEASUREMENT
Application of infrared frequency synthesis techniques with metal-insulator-metal diodes to the spin flip Raman laser, 2:41906 (PB-254066)
SERUM (IMMUNE)
See IMMUNE SERUMS
SERVICE WATER SYSTEMS
See AUXILIARY WATER SYSTEMS
SEWAGE
See LIQUID WASTES
SEWAGE SLUDGE/BIOLOGICAL RADIATION EFFECTS
Beneficial Uses Program progress report, period ending December 31, 1976 (Gamma inactivation of microorganisms in sewage sludge), 2:42074 (SAND-77-0426)
SEWAGE SLUDGE/USES
Evaluation of proposed man-made ponds for food production to recover values in waste heat and solid organic sludges. Completion report, 2:41699 (PB-258773)
SEWAGE TREATMENT
See WASTE PROCESSING
SGHWR REACTOR/FUEL ELEMENTS
SGHWR fuel performance, safety and reliability, 2:41366 (IAEA-CN-36/63)
SGHWR REACTOR/SAFETY ENGINEERING
SGHWR safety design and evaluation, 2:41514 (IAEA-CN-36/73)
SHALE OIL/CATALYTIC CRACKING
Methods for refining crude shale oil produced by in situ retorting, 2:41056
SHALE OIL/HYDROGENATION
Catalytic reforming of hydrogenated shale-oil naphtha, 2:41054
Hydrogenating shale oil at low space velocity, 2:41055
Methods for refining crude shale oil produced by in situ retorting, 2:41056
Refining improvement of shale-oil naphtha, 2:41053
SHALE OIL/REFINING
Methods for refining crude shale oil produced by in situ retorting, 2:41056
SHEATHS (FUEL)
See FUEL CANS
SHF RADIATION
See RADIOWAVE RADIATION
SHIELDING
Gas-cooled fast breeder reactor. Quarterly progress report, November 1, 1976-January 31, 1977, 2:41384 (GA-A-14240)
SHIELDING/MATHEMATICAL MODELS
Direct-coupled-ray method for three-dimensional shielding analysis, 2:41467 (CONF-770401-9)
SHIELDING/RADIATION STREAMING
Spatial channel theory: A technique for determining the directional flow of radiation through reactor systems, 2:41468 (CONF-770401-13)
SHIP PROPULSION REACTORS/REACTOR OPERATION
Nuclear merchant ship propulsion, 2:41507 (IAEA-CN-36/93)
SHIPMENT
See TRANSPORT

SHIPS
See also NUCLEAR SHIPS
SUBMARINES
TANKER SHIPS
SHIPS/CONSTRUCTION
Design, material and production - a complex problem within shipbuilding, 2:40935
SHIPS/DESIGN
Design, material and production - a complex problem within shipbuilding, 2:40935
SHOCK WAVES/ELECTRON DENSITY
Photo-excitation and photo-ionization ahead of a strong shock wave in argon, 2:42232
SID
See SUDDEN IONOSPHERIC DISTURBANCE
SILICA/BIOLOGICAL EFFECTS
Hematopoietic effects (Effects of internal ^{90}Sr and ^{226}Ra radiation, whole-body γ irradiation, and i.v.-administered fly ash silica particles), 2:42081 (UCD-472-123)
SILICON/CRYSTAL GROWTH
Heat exchanger-ingot casting/slicing process. Silicon sheet growth development for the large area silicon sheet task of the low cost silicon solar array project. Fifth quarterly progress report, September 25, 1976-December 16, 1976, 2:41181 (ERDA/JPL/954373-76/5)
Large area Czochralski silicon. Quarterly report No. 3, 2:41184 (ERDA/JPL/954475-76/3)
SILICON/CUTTING
Heat exchanger-ingot casting/slicing process. Silicon sheet growth development for the large area silicon sheet task of the low cost silicon solar array project. Fifth quarterly progress report, September 25, 1976-December 16, 1976, 2:41181 (ERDA/JPL/954373-76/5)
Large area Czochralski silicon. Quarterly report No. 3, 2:41184 (ERDA/JPL/954475-76/3)
Slicing of silicon into sheet material. Silicon sheet growth development for the large area silicon sheet task of the low cost silicon solar array project. Third quarterly report, September 20, 1976-December 19, 1976, 2:41182 (ERDA/JPL/954374-76/4)
SILICON ALLOYS/MAGNETIZATION
Itinerant magnetism in $NpFe_2Si_2$ and $NpCo_2Si_2$, 2:41799
SILICON CARBIDES/MECHANICAL PROPERTIES
Estimate of low-Z materials for the first wall of JT-60, 2:42317 (JAERI-M-6432)
SILICON CARBIDES/PHYSICAL PROPERTIES
Estimate of low-Z materials for the first wall of JT-60, 2:42317 (JAERI-M-6432)
SILICON CARBIDES/RADIOACTIVATION
Low activation materials assessment for fusion reactors, 2:42315 (EPRI-ER-328-SR)
SILICON SOLAR CELLS/COVERINGS
Accelerated/abbreviated test methods, study 4 of task 3 (encapsulation) of the low-cost silicon solar array project. Third quarterly progress report, October-December 1976 (Leyan, Tedlar, and polystyrene films), 2:41183 (ERDA/JPL/954458-76/3)
SILICON SOLAR CELLS/MATHEMATICAL MODELS
Simulation of silicon solar cells and comparison with experimental results, 2:41194 (N-76-29705)
SILICON SOLAR CELLS/PERFORMANCE
Results from the IMP-J violet solar cell experiment and violet cell balloon flights, 2:41188 (N-76-30657)
SILICON SOLAR CELLS/RESEARCH PROGRAMS
Development of 20% efficient solar cell. Final project report 1 Jun 74-31 Aug 75, 2:41189 (PB-255903)
SILICON SOLAR CELLS/WEATHERING
Accelerated/abbreviated test methods, study 4 of task 3 (encapsulation) of the low-cost silicon solar array project. Third quarterly progress report, October-December 1976 (Leyan, Tedlar, and polystyrene films), 2:41183 (ERDA/JPL/954458-76/3)
SILVER/ABSORPTION SPECTROSCOPY
Evaluation of a carbon-rod atomizer for routine determination of trace metals by atomic-absorption spectroscopy. Applications to analysis of lubricating oil and crude oil, 2:41016
SILVER/X-RAY EMISSION ANALYSIS
Investigation of size-dependent concentration of trace elements in aerosols emitted from the oil-fired heating plants, 2:40986 (N-76-27720)
SILVER BASE ALLOYS/DEPOSITION
Sputter-deposition of metastable Ta-Pu, Ag-Pu and Co-Pu alloys, 2:41759
SILVER BASE ALLOYS/SPUTTERING
Sputter-deposition of metastable Ta-Pu, Ag-Pu and Co-Pu alloys, 2:41759
SILVER-CADMIUM BATTERIES/CATHODES
Life capability of the silver electrode in alkaline electrochemical cells (Ag-H_2), 2:41576 (N-76-28648)
SILVER-ZINC BATTERIES/CATHODES
Life capability of the silver electrode in alkaline electrochemical cells (Ag-H_2), 2:41576 (N-76-28648)
SILVER-ZINC BATTERIES/FABRICATION
Fabrication and testing of sealed silver-zinc cells. Final report, 2:41572 (N-76-27673)
SILVER-ZINC BATTERIES/PERFORMANCE TESTING
Fabrication and testing of sealed silver-zinc cells. Final report, 2:41572 (N-76-27673)
SKIN/BIOLOGICAL RADIATION EFFECTS
Photosensitizing effects of 8-methoxypsoralen on the skin of hairless mice. I. Formation of interstrand cross-links in epidermal DNA (UV radiation), 2:42083
SKIN/NEOPLASMS
Review of the carcinogenicities of nickel, chromium, and arsenic compounds in man and animals, 2:42132
SKIN/PHOTOSENSITIVITY
Photosensitizing effects of 8-methoxypsoralen on the skin of hairless mice. I. Formation of interstrand cross-links in epidermal DNA (UV radiation), 2:42083
SLAGS/ELECTRIC CONDUCTIVITY
Electrical conductivity of coal slag, 2:40849
SLUGS (FUEL)
See FUEL RODS
SMELTING/AIR POLLUTION CONTROL
Evaluation of SO_2 emission control technology applicable to the East Helena lead smelter. Final report, 2:41965 (PB-255277)
SMOG/BIOLOGICAL EFFECTS
Report of a nationwide survey of photo-chemical smog using the morning glory as an indicator, 2:41986 (PB-254560-T/SL)
SNOW
Quarterly Bulletin of the Division of Mechanical Engineering and the National Aeronautical Establishment, Ottawa, 1 July to 30 September 1976, 2:41710 (AD-A-034552)
SNR REACTOR
See SNR-1 REACTOR
SNR-1 REACTOR/FUEL ELEMENTS
Introducing experimental evidence in critical aspects of SNR fuel design, 2:41403 (IAEA-CN-36/489)
SNR-300 REACTOR
See SNR-1 REACTOR
SODIUM/ABSORPTION SPECTROSCOPY
Determination of trace metals in crude oils by nonflame atomic absorption spectroscopy, 2:41014
SODIUM/ACTIVATION ANALYSIS
Application of Bremsstrahlung activation analysis to the determination of carbon and nitrogen in sodium, 2:41865 (CEA-CONF-3657)
Mode of occurrence of trace elements in petroleum and relationship to oil-spill identification methods, 2:41027
SODIUM/BIOLOGICAL EFFECTS
Slow phase hemolysis in hypotonic electrolyte solutions, 2:42028
SODIUM/CORROSIVE EFFECTS
Creep and creep--rupture properties of $2^1/_4$Cr2Mo steel for fast breeder reactor in high temperature sodium, 2:41794
SODIUM/VOID COEFFICIENT
Critical experiments and analysis twenty-first quarterly report, October-December 1976 (LMFBR), 2:41386 (GEAP-13771-21)
SODIUM 22/COSMOCHEMISTRY
Cosmogenic radionuclides in stone meteorites, 2:42173 (N-76-25115)
SODIUM 22 TARGET/NEUTRON REACTIONS
Neutron absorption cross section of sodium 22 (Westcott procedure), 2:42201
SODIUM ALLOYS/PHYSICAL PROPERTIES
Study of NaK flow and heat transfer, (1). Tabulation of the physical quantities of NaK, 2:41796 (PNC-N-941-75-113)
SODIUM-SULFUR BATTERIES/CATHODES
Anodic evolution of sulphur from sodium polysulphide melts. I. Voltammetric measurements on planar carbon electrodes, 2:41573
Metallic sulfide additives for positive electrode material within a secondary electrochemical cell (Patent; Fe sulfide electrode with sulfide additives of Co, Ni, Cu, Ce, Mn), 2:41577
SODIUM-SULFUR BATTERIES/ELECTROCHEMISTRY
Anodic evolution of sulphur from sodium polysulphide melts. I. Voltammetric measurements on planar carbon electrodes, 2:41573
SOILS
Soil and ground water considerations (Earth-covered construction), 2:41594 (NSF-RA-760006)
SOILS/EROSION
Erosion and sediment control audiovisual training program instructor's workbook. Final report, 2:41999 (PB-258471)
SOILS/RADIOACTIVITY
Report of ambient outdoor radon and indoor radon progeny concentrations during November 1975 at selected locations in the grants mineral belt, New Mexico. Final technical note, 2:41996 (PB-258257)

SOILS/THERMAL DIFFUSIVITY
Effect of ground cover on Earth temperature, 2:41596 (NSF-RA-760006)
SOLAR ACTIVITY
See also SOLAR FLARES
SOLAR WIND
SOLAR X-RAY BURSTS
Synoptic approach to sun-weather investigations, 2:42167 (N-76-29863)
SOLAR ACTIVITY/CORRELATIONS
Study of the relationship between solar activity and terrestrial weather, 2:42165 (N-76-28742)
SOLAR ACTIVITY/TABLES
Solar-geophysical data number 387. Part II. Comprehensive reports. Data for May 1976-April 1976 and miscellanea. Explanation of data reports issued as number 378 (supplement) February 1976, 2:42170 (PB-263007)
Solar-geophysical data number 387. Part I. Prompt reports. Data for October 1976-September 1976. Explanation of data reports issued as number 378 (supplement) February 1976, 2:42171 (PB-263008)
SOLAR AIR CONDITIONERS
An investigation of the acceptance of solar heating and cooling in the housing industry in New Mexico. Final technical report, 1 Aug 1975-31 Jul 1976, 2:41205 (N-76-28652)
SOLAR AIR CONDITIONERS/BIBLIOGRAPHIES
Development of a solar-powered residential air conditioner (Rankine cycle power systems), 2:41208 (N-76-30656)
SOLAR AIR CONDITIONERS/DEMONSTRATION PROGRAMS
Analysis of solar energy system for the GSA demonstration office building at Manchester, New Hampshire. Final report, 2:41211 (PB-254179)
SOLAR AIR CONDITIONERS/ECONOMICS
Development of a solar-powered residential air conditioner: economic analysis (Rankine cycle power system), 2:41206 (N-76-30653)
SOLAR AIR CONDITIONERS/MATHEMATICAL MODELS
Simulation and operation of a solar powered organic Rankine cycle turbine, 2:41223
SOLAR AIR CONDITIONERS/OPTIMIZATION
Development of a solar-powered residential air conditioner: screening analysis (RAnkine cycle power systems), 2:41209 (N-76-30659)
Development of a solar-powered residential air conditioner: system optimization preliminary specification (Rankine cycle power system), 2:41210 (N-76-30660)
SOLAR AIR CONDITIONERS/PERFORMANCE TESTING
Development of a solar powered residential air conditioner (general optimization). Final report, 2:41203 (N-76-24702)
SOLAR AIR CONDITIONERS/RESEARCH PROGRAMS
Development of a solar-powered residential air conditioner. Program review, 2:41207 (N-76-30655)
SOLAR AIR CONDITIONING/RANKINE CYCLE POWER SYSTEMS
Development of a solar-powered residential air conditioner: economic analysis (Rankine cycle power system), 2:41206 (N-76-30653)
Development of a solar-powered residential air conditioner (Rankine cycle power systems), 2:41208 (N-76-30656)
Development of a solar-powered residential air conditioner: screening analysis (RAnkine cycle power systems), 2:41209 (N-76-30659)
Development of a solar-powered residential air conditioner: system optimization preliminary specification (Rankine cycle power system), 2:41210 (N-76-30660)
SOLAR CELL ARRAYS/ECONOMICS
Assessment of cadmium sulfide photovoltaic arrays for large scale electric utility applications. Final report, 2:41199 (PB-255646)
SOLAR CELL ARRAYS/PERFORMANCE
Conceptual approach study of a 200-watt-per-kilogram solar array. Quarterly report, 2:41187 (N-76-28651)
SOLAR CELL ARRAYS/TESTING
Thermal vacuum accelerated life test of the unit qualification model msds 3 marconi low speed mechanism, 2:41185 (N-76-27586)
SOLAR CELLS
See also CADMIUM SULFIDE SOLAR CELLS
GALLIUM ARSENIDE SOLAR CELLS
SILICON SOLAR CELLS
SOLAR CELLS/COST
Solar cells, 2:41192 (N-76-28653)
SOLAR CELLS/EFFICIENCY
Physical characterization of silicon solar cells by determination of spectral response, 2:41193 (N-76-28644)
SOLAR COLLECTORS
See also FLAT PLATE COLLECTORS
SOLAR COLLECTORS/FLOW MODELS
Temperature distribution along an absorbing-emitting fluid layer flowing over an opaque substrate (Molten salt solar cavity), 2:41230
SOLAR COLLECTORS/HONEYCOMB STRUCTURES
Performance measurements of a cylindrical glass honeycomb solar collector compared with predictions, 2:41229
SOLAR COLLECTORS/PERFORMANCE
Method for estimating hourly averages of diffuse and direct solar radiation under a layer of scattered clouds (For calculating performance of various collectors), 2:41179
SOLAR COLLECTORS/PERFORMANCE TESTING
Analysis of solar energy system for the GSA demonstration office building at Manchester, New Hampshire. Final report, 2:41211 (PB-254179)
Performance measurements of a cylindrical glass honeycomb solar collector compared with predictions, 2:41229
Terraset Elementary School, Reston, Virginia (Underground, solar-heated), 2:41616 (NSF-RA-760006)
SOLAR COLLECTORS/SPECTRALLY SELECTIVE SURFACES
Cadmium stannate selective optical films for solar energy applications. Final report, 1 Jul 1973-31 Aug 1976, 2:41228 (PB-261850)
SOLAR COLLECTORS/TEMPERATURE DISTRIBUTION
Temperature distribution along an absorbing-emitting fluid layer flowing over an opaque substrate (Molten salt solar cavity), 2:41230
SOLAR COLLECTORS/TEMPERATURE EFFECTS
The transient thermal response of a tubular solar collector, 2:41227 (N-76-28649)
SOLAR COOLING SYSTEMS
See SOLAR AIR CONDITIONERS
SOLAR CORONA
Optical observations from the Voskhod-2 spacecraft, 2:42172 (N-76-28122)
SOLAR CORONA/ENERGY TRANSPORT
Multi-satellite attitude prediction program/Orbiting Solar Observatory-8 (MSAP/OSO-8) operating guide, 2:42164 (N-76-27304)
SOLAR CYCLE
Measures of the solar spectral irradiance between 1200 and 3000 a, 2:42169 (N-76-31126)
SOLAR ENERGY/ENVIRONMENTAL IMPACTS
Solar program assessment: environmental factors (Analysis based on system of 1000 single-family residences), 2:41180 (ERDA-77-47/5)
SOLAR ENERGY/TECHNOLOGY ASSESSMENT
Solar energy: one way to citizen control, 2:41657
SOLAR ENERGY CONVERSION/FORECASTING
Solar energy in America's future: a preliminary assessment, 2:41656 (DSE/115-1)
SOLAR ENERGY CONVERSION/TECHNOLOGY ASSESSMENT
Solar energy in America's future: a preliminary assessment, 2:41656 (DSE/115-1)
Solar energy: one way to citizen control, 2:41657
SOLAR FLARES/SHAPE
Observations of limb flares with a soft x-ray telescope, 2:42163 (N-76-27149)
SOLAR FLARES/TABLES
Solar-geophysical data number 387. Part II. Comprehensive reports. Data for May 1976-April 1976 and miscellanea. Explanation of data reports issued as number 378 (supplement) February 1976, 2:42170 (PB-263007)
Solar-geophysical data number 387. Part I. Prompt reports. Data for October 1976-September 1976. Explanation of data reports issued as number 378 (supplement) February 1976, 2:42171 (PB-263008)
SOLAR FLUX/ABSORPTIVITY
Method for measuring the solar absorption factor, 2:41225 (N-76-27433)
SOLAR FLUX/DATA
Compilation of solar data for White Sands Missile Range, 2:41232 (AD-A-029155)
SOLAR FLUX/MEASURING METHODS
Method for estimating hourly averages of diffuse and direct solar radiation under a layer of scattered clouds (For calculating performance of various collectors), 2:41179
SOLAR HEAT ENGINES/MATHEMATICAL MODELS
Simulation and operation of a solar powered organic Rankine cycle turbine (32 kW), 2:41223
SOLAR HEATING/MEASURING METHODS
Method for measuring the solar absorption factor, 2:41225 (N-76-27433)
SOLAR HEATING SYSTEMS
An investigation of the acceptance of solar heating and cooling in the housing industry in New Mexico. Final technical report, 1 Aug 1975-31 Jul 1976, 2:41205 (N-76-28652)

Low-energy house in Vetlanda, 2:41222
SOLAR HEATING SYSTEMS/DEMONSTRATION PROGRAMS
Analysis of solar energy system for the GSA demonstration office building at Manchester, New Hampshire. Final report, 2:41211 (PB-254179)
SOLAR HEATING SYSTEMS/INSTALLATION
Inexpensive economical solar heating system for homes, 2:41204 (N-76-27671)
SOLAR HEATING SYSTEMS/MODIFICATIONS
Assessment of a single family residence solar heating system in a suburban development setting. Monthly report, 10 Aug-10 Sep 1975, 2:41216 (PB-255049)
SOLAR HEATING SYSTEMS/OPERATION
Houses in Linkoping heated with solar energy, 2:41219
Termoroc house in Limhamn, 2:41220
Zero-energy house in Lyngby, 2:41221
SOLAR HEATING SYSTEMS/PERFORMANCE
Assessment of a single family residence solar heating system in a suburban development setting. Monthly report, 2:41214 (PB-254495)
Assessment of a single family residence solar heating system in a suburban development setting. Monthly report, 2:41215 (PB-254502)
Inexpensive economical solar heating system for homes, 2:41204 (N-76-27671)
SOLAR HEATING SYSTEMS/PERFORMANCE TESTING
Assessment of a single family residence solar heating system in a suburban development setting. Monthly report, 2:41212 (PB-254493)
Assessment of a single family residence solar heating system in a suburban development setting. Monthly report, 2:41213 (PB-254494)
SOLAR PARTICLES/INTERACTIONS
Multi-satellite attitude prediction program/Orbiting Solar Observatory-8 (MSAP/OSO-8) operating guide, 2:42164 (N-76-27304)
SOLAR PARTICLES/TABLES
Solar-geophysical data number 387. Part II. Comprehensive reports. Data for May 1976-April 1976 and miscellanea. Explanation of data reports issued as number 378 (supplement) February 1976, 2:42170 (PB-263007)
SOLAR POWER PLANTS
See also PHOTOVOLTAIC POWER PLANTS
SOLAR THERMAL POWER PLANTS
SOLAR POWER PLANTS/ECONOMICS
Cost of energy from utility-owned solar electric systems. A required revenue methodology for ERDA/EPRI evaluations, 2:41200 (N-76-28647)
SOLAR POWER PLANTS/SITE SELECTION
Solar microclimatology. Final report (Data for Arizona), 2:41233 (N-76-28738)
SOLAR PROTON EVENTS
See POLAR-CAP ABSORPTION
SOLAR RADIATION/POLARIZATION
Rutgers zodiacal light experiment on OSO-6. Final report, 2:42168 (N-76-30257)
SOLAR RADIOWAVE RADIATION/TABLES
Solar-geophysical data number 387. Part II. Comprehensive reports. Data for May 1976-April 1976 and miscellanea. Explanation of data reports issued as number 378 (supplement) February 1976, 2:42170 (PB-263007)
Solar-geophysical data number 387. Part I. Prompt reports. Data for October 1976-September 1976. Explanation of data reports issued as number 378 (supplement) February 1976, 2:42171 (PB-263008)
SOLAR SPACE HEATING/EFFICIENCY
Solar energy: one way to citizen control, 2:41657
SOLAR SPACE HEATING/MATHEMATICAL MODELS
Simulation and operation of a solar powered organic Rankine cycle turbine, 2:41223
SOLAR SPACE HEATING/SCHOOL BUILDINGS
Terraset Elementary School, Reston, Virginia (Underground, solar-heated), 2:41616 (NSF-RA-760006)
SOLAR THERMAL POWER PLANTS/FEASIBILITY STUDIES
Energy storage: feasibility study to collect, store and release energy from solar origin, using a kinetic battery stockage, 2:41565 (N-76-27695)
SOLAR THERMAL POWER PLANTS/FLYWHEEL ENERGY STORAGE
Energy storage: feasibility study to collect, store and release energy from solar origin, using a kinetic battery stockage, 2:41565 (N-76-27695)
SOLAR WATER PUMPS/DEMONSTRATION PROGRAMS
Solar powered irrigation system. Quarterly progress report to ERDA/DSE, 2:41224 (SAND-76-0358)
SOLAR WIND/INTERACTIONS
Mass fractionation of the lunar surface by solar wind sputtering, 2:42150 (N-76-31119)
SOLAR WIND/TABLES
Solar-geophysical data number 387. Part II. Comprehensive reports. Data for May 1976-April 1976 and miscellanea. Explanation of data reports issued as number 378 (supplement) February 1976, 2:42170 (PB-263007)
Solar-geophysical data number 387. Part I. Prompt reports. Data for October 1976-September 1976. Explanation of data reports issued as number 378 (supplement) February 1976, 2:42171 (PB-263008)
SOLAR X-RAY BURSTS/TABLES
Solar-geophysical data number 387. Part I. Prompt reports. Data for October 1976-September 1976. Explanation of data reports issued as number 378 (supplement) February 1976, 2:42171 (PB-263008)
SOLID FUELS
See also DISPERSION NUCLEAR FUELS
SOLID FUELS/OXIDATION
Method of determining the suitability of a solid fuel for storage, 2:40909
SOLID FUELS/STORAGE
Method of determining the suitability of a solid fuel for storage, 2:40909
SOLID SCINTILLATION DETECTORS/CALIBRATION
Calibration techniques and error analysis for phoswich counting of actinide nuclides at Oak Ridge National Laboratory, 2:42096 (BNWL-2088)
LLL plutonium lung counter calibration and discussion of errors, 2:42105 (BNWL-2088)
SOLID SCINTILLATION DETECTORS/PERFORMANCE TESTING
Calibration techniques for the in vivo measurement of alpha-emitting actinides (In lungs), 2:42102 (BNWL-2088)
Measurement of transuranic elements in vivo at CRNL (Personnel monitoring at nuclear fuel fabrication plant), 2:42103 (BNWL-2088)
Present status of and future plans for ITRI's human and dog chest counting facilities, 2:42106 (BNWL-2088)
SOLID STATE PHYSICS/ELECTROCHEMISTRY
Materials research at Stanford University. Annual report, 1 Jul 1975-30 Jun 1976, 2:41862 (N-76-30026)
SOLID STATE PHYSICS/RESEARCH PROGRAMS
Theory of solid surfaces. Final scientific report 1 Oct 1972-30 Sep 1975, 2:42209 (AD-A-031022)
SOLID WASTES
See also REFUSE DERIVED FUELS
WOOD WASTES
SOLID WASTES/ENERGY SOURCES
Markets and technology for recovering energy from solid waste, 2:41259 (PB-253326)
SOLID WASTES/MATERIALS RECOVERY
Decision-makers guide in solid waste management, 2:41698 (PB-258266)
Gradd regional solid waste plan, 2:41697 (PB-258260)
Optimization of office paper recovery systems. Final report, 2:41695 (PB-257955)
SOLID WASTES/RECYCLING
Predictive criteria for construction/demolition solid waste management. Final report, 2:41690 (AD-A-034419)
Recovering resources from solid waste using wet processing. EPA's Franklin, Ohio demonstration project, 2:41691 (PB-253330)
Resource recovery and source reduction. First report to Congress, 2:41693 (PB-255139)
Resource recovery and waste reduction. Third report to Congress, 2:41694 (PB-255141)
SOLID WASTES/STORAGE
Coal technology program progress report for January 1977, 2:40731 (ORNL/TM-5819)
SOLID WASTES/WASTE DISPOSAL
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
SOLID WASTES/WASTE MANAGEMENT
Decision-makers guide in solid waste management, 2:41698 (PB-258266)
Gradd regional solid waste plan, 2:41697 (PB-258260)
Implementing 'best management practices' for residuals: the waste exchange, 2:41696 (PB-258068)
Predictive criteria for construction/demolition solid waste management. Final report, 2:41690 (AD-A-034419)
SOLITONS/WAVE PROPAGATION
Propagation of ion acoustic solitons in a warm ion plasma, 2:42264
Propagation of ion acoustic solitons in a two component plasma, 2:42265
SOLVENT-REFINED COAL/COMBUSTION
Coal power and combustion. Quarterly report, April-June 1976, 2:40907 (ERDA-76-94/2)
Laboratory analysis of solvent refined coal. Technical report No. 1, 2:40801 (PB-255550)

SOLVENT-REFINED COAL/COMBUSTION PROPERTIES
Investigating storage, handling, and combustion characteristics of solvent refined coal. Task C extension, ball-and-race pulverization and direct firing. Final report, 2:40900 (PB-257551)
SOLVENT-REFINED COAL/GRINDING
Investigating storage, handling, and combustion characteristics of solvent refined coal. Task C extension, ball-and-race pulverization and direct firing. Final report, 2:40900 (PB-257551)
Solvent refined coal evaluation: pulverization, storage, and combustion. Technical report No. 2, 2:40802 (PB-2557029)
SOLVENT-REFINING COAL PLANTS
See COAL PREPARATION PLANTS
SOUTH AFRICA/COAL MINING
Delmas breaks coal output barrier, 2:40898
SOUTH AFRICA/NUCLEAR POWER
South Africa's nuclear energy analysis, 2:41442
SOVIET UNION
See USSR
SPACE POWER REACTORS/POWER CONDITIONING CIRCUITS
Electric power-conditioning for a thermionic generator (Space satellite thermionic reactor), 2:41428
SPACE VEHICLES/PHYSICAL RADIATION EFFECTS
Low fluxes of x rays. Final report (Interactions of high-energy protons with spacercraft materials and typical materials for scintillation detectors), 2:41936 (N-76-30279)
SPACE VEHICLES/SPACECRAFT POWER SUPPLIES
Nuclear powered satellite design for shuttle launches, 2:41157
SPACECRAFT POWER SUPPLIES/FUEL CELLS
Space shuttle engineering and operations support. Orbiter to spacelab electrical power interface. Avionics system engineering, 2:41665 (N-76-28340)
SPACECRAFT POWER SUPPLIES/SOLAR CELL ARRAYS
Conceptual approach study of a 200-watt-per-kilogram solar array. Quarterly report, 2:41187 (N-76-28651)
SPACECRAFT POWER SUPPLIES/THERMOELECTRIC GENERATORS
Fracture behavior of a Pt-30% Rh-8% W alloy between room temperature and 1300°c, 2:41156
SPAIN/RADIOACTIVE WASTE MANAGEMENT
Spanish program on disposal of radioactive wastes, 2:41118 (IAEA-CN-36/206)
SPE
See POLAR-CAP ABSORPTION
SPECTRALLY SELECTIVE SURFACES/FABRICATION
Cadmium stannate selective optical films for solar energy applications. Final report, 1 Jul 1973-31 Aug 1976, 2:41228 (PB-261850)
Improvement of black nickel coatings. Final report (For flat plate solar collectors), 2:41226 (N-76-28404)
SPECTRALLY SELECTIVE SURFACES/PERFORMANCE
Cadmium stannate selective optical films for solar energy applications. Final report, 1 Jul 1973-31 Aug 1976, 2:41228 (PB-261850)
Improvement of black nickel coatings. Final report (For flat plate solar collectors), 2:41226 (N-76-28404)
SPENT FUEL CASKS/DESIGN
Spent fuel transportation problems, 2:41108 (IAEA-CN-36/316)
SPENT FUEL CASKS/PERFORMANCE
Experience of European irradiated fuel transport - the first four hundred tonnes, 2:41106 (IAEA-CN-36/69)
SPENT FUEL ELEMENTS/FABRICATION
Present status of fuel researches for VHTR in Japan, 2:41357 (IAEA-CN-36/168)
SPENT FUEL ELEMENTS/HEAD END PROCESSES
Thorium utilization program. Quarterly progress report for the period ending February 28, 1977, 2:41093 (GA-A-14304)
SPENT FUEL ELEMENTS/TRANSPORT
Experience of European irradiated fuel transport - the first four hundred tonnes, 2:41106 (IAEA-CN-36/69)
Some UK experience and practice in the packaging and transport of irradiated fuel, 2:41107 (IAEA-CN-36/70)
SPENT FUEL STORAGE
Iodine to control microbiological growth in fuel storage basin water, 2:41109 (ICP-1109)
SPENT FUEL STORAGE/CRITICALITY
Criticality control and long term storage of spent fuel, 2:41105 (IAEA-CN-36/33)
SPENT FUEL STORAGE/RADIOACTIVE WASTE MANAGEMENT
Waste management implications of irradiated nuclear fuel storage, 2:41104 (IAEA-CN-36/23)
SPENT FUELS/ACCIDENTS
Potential releases of cesium from irradiated fuel in a transportation accident. Supplement II to WASH-1238. Environmental survey of transportation of radioactive materials to and from nuclear power plants. Technical report, 2:41110 (PB-254786)
SPENT FUELS/GAMMA FUEL SCANNING
In-pile gamma scanning. Application to power and burnup measurement and to the study of fission product migration, 2:41486 (CEA-CONF-3663)
SPENT FUELS/REPROCESSING
Thorium utilization program. Quarterly progress report for the period ending February 28, 1977 (Fuel element crushing, burning; particle classification; solvent extraction; dry solids handling; plant management; HET fuel shipping; HTGR recycle demonstration facility), 2:41093 (GA-A-14304)
SPENT FUELS/TRANSPORT
Research and development of spent fuel shipping casks and the criteria for seagoing vessel carrying casks, 2:41889 (IAEA-CN-36/155)
Spent fuel transportation problems, 2:41108 (IAEA-CN-36/316)
SPENT SHALES/CHEMICAL COMPOSITION
Chemical composition and effectiveness of oil shale ash and cement kiln flue dust as liming fertilizers, 2:41069 (PB-254559-T/SL)
SPENT SHALES/COMPACTORS
Field compaction tests. Research and development program on the disposal of retorted oil shale-Paraho Oil Shale Project. Open file report, 2:41068 (PB-254728)
SPENT SHALES/USES
Chemical composition and effectiveness of oil shale ash and cement kiln flue dust as liming fertilizers, 2:41069 (PB-254559-T/SL)
SPLEEN CELLS/CELL PROLIFERATION
Inhibition of erythroid cell growth in irradiated mice by allogeneic lymphoid cells: specificity of the response (X Radiation), 2:42071
SPRAY PONDS
See COOLING PONDS
SPREAD F
Study of the conditions necessary for the onset of mid-latitude spread F, 2:42185 (N-76-29782)
SQUIRRELS/HORMONES
Age and seasonal differences in the synthesis and metabolism of testosterone by testicular tissue and pineal HIOMT activity of Uinta ground squirrels (Spermophilus armatus), 2:42057
STADE REACTOR/REACTOR CONTROL SYSTEMS
Reactor power control by a dual 305 computer system at Stade nuclear power station, 2:41490
STAINLESS STEEL-304/STRESS CORROSION
Caustic stress corrosion cracking (LMFBR), 2:41388 (HEDL-SA-1122)
STAINLESS STEEL-316/PHYSICAL RADIATION EFFECTS
Fusion power program. Quarterly progress report, October-December 1976, 2:42314 (ANL/FPP-76-6)
STAINLESS STEEL-316/STRESS CORROSION
Caustic stress corrosion cracking (LMFBR), 2:41388 (HEDL-SA-1122)
STAINLESS STEELS
See also STAINLESS STEEL-304
STAINLESS STEEL-316
STAINLESS STEELS/MECHANICAL PROPERTIES
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)
STAINLESS STEELS/MELTING
M551 metals melting experiment, 2:41757 (N-76-27401)
STAINLESS STEELS/MICROSTRUCTURE
M551 metals melting experiment, 2:41757 (N-76-27401)
STAINLESS STEELS/PASSIVATION
The role of passive film growth kinetics and properties in stress corrosion and crevice corrosion susceptibility. Technical summary report No. 7, Oct 1975-Nov 1976, 2:41812 (AD-A-034723)
STAINLESS STEELS/PHYSICAL RADIATION EFFECTS
Experimental study associated to irradiation of FBR structural material, (4), 2:41819 (PNC-J-259-76-01)
STAINLESS STEELS/THERMAL CONDUCTIVITY
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)
STAINLESS STEELS/WELDING
M551 metals melting experiment, 2:41757 (N-76-27401)
STANDING CROP
See BIOMASS
STAR EVOLUTION
The relativistic equations of stellar structure and evolution. stars with degenerate neutron cores. I. Structure of equilibrium models, 2:42152 (N-76-27134)
STAR MODELS
The relativistic equations of stellar structure and evolution. stars with degenerate neutron cores. I. Structure of equilibrium models, 2:42152 (N-76-27134)
STARS
See also BINARY STARS
SUN

STARS/ABSORPTION SPECTRA
Orbital changes of the gaseous ring around B/sub e/ stars (Theory to explain erratic V/R variations), 2:42156 (N-76-30126)
STARS/EMISSION SPECTRA
Orbital changes of the gaseous ring around B/sub e/ stars (Theory to explain erratic V/R variations), 2:42156 (N-76-30126)
STARS/PHOTOMETRY
Photometric study of the Orion OB 1 association. 1. Observational data, 2:42153 (N-76-28125)
STARS/ULTRAVIOLET SPECTRA
Line identifications in the ultraviolet spectra of tau Herculis, B5 IV, and zeta Draconis, B6 III, 2:42155 (N-76-29099)
STATE DIAGRAMS
See PHASE DIAGRAMS
STATISTICS/COMPUTER CODES
CDC6600 subroutine for normal random variables (RVNORM (RMU, SIG)), 2:42329 (SAND-77-0612)
STATISTICS/TABLES
Variances and covariances of the normal order statistics for sample sizes 2 to 50, 2:42327 (LA-6482-MS)
STEAM CONDENSERS/CORROSION PROTECTION
Corrosion in condensers and coolers of nuclear power due to cooling water, 2:41813 (EBO-P-673)
STEAM GENERATING HEAVY WATER REACTOR
See SGHWR REACTOR
STEAM GENERATORS/BAFFLED TUBES
Thermal mechanical analysis procedure for a semicircular plate with clamped straight edge (U-tube steam generator divider plate), 2:41474
STEAM GENERATORS/BURNOUT
Burn-out power in once-through tubular steam generators (LMFBR), 2:41410
STEAM GENERATORS/CORROSION
Sodium heated steam generator tube wastage due to water/steam to sodium leaks--theory and correlation, 2:41420
STEAM GENERATORS/DESIGN
Recent design concepts for coal firing, 2:41923
Structural and thermal-hydraulic design of a sodium heated duplex bayonet tube steam generator, 2:41419
STEAM GENERATORS/FLUE GAS
Graphs for determination of exhaust gases and radiation heat exchanger size in steam generators, 2:41266
STEAM GENERATORS/FOULING
Post-critical heat flux fouling by system corrosion products in a model sodium heated steam generator, 2:41423
STEAM GENERATORS/HEAT EXCHANGERS
Graphs for determination of exhaust gases and radiation heat exchanger size in steam generators, 2:41266
STEAM GENERATORS/HEAT TRANSFER
Modeling the effect of inventory loss on steam generator heat transfer (PWR), 2:41343
STEAM GENERATORS/IN-SERVICE INSPECTION
Element-type steam generators inspection with regard to operating reliability, 2:41471 (INIS-mf-3389)
STEAM GENERATORS/LEAKS
Sodium heated steam generator tube wastage due to water/steam to sodium leaks--theory and correlation, 2:41420
STEAM GENERATORS/MOLTEN METAL-WATER REACTIONS
Design considerations for systems subject to sodium/water reactions, 2:41413
STEAM GENERATORS/PERFORMANCE TESTING
Functional performance of a two-tube helically-coiled once-through steam generator (PWR), 2:41342
STEAM GENERATORS/QUALITY ASSURANCE
Quality assurance of production of steam generators and volume compensators for WWER-440 type nuclear power plants, 2:41336 (INIS-mf-3389)
STEAM GENERATORS/STRESS ANALYSIS
Three-dimensional finite element analysis of a steam generator channel-head-complex: comparison of theory and experiment, 2:41475
STEAM GENERATORS/WATER CHEMISTRY
Feedwater chemistry requirements for HTGR steam generator operation, 2:41365
STEAM LINES/STRESS ANALYSIS
Inelastic response of nuclear piping subjected to rupture forces (Water cooled reactors), 2:41541
STEAM SUPERHEATERS
See SUPERHEATERS
STEAM TURBINES/LUBRICATION
Service performance of steam-turbine oils: oxidation stability and the predominant causes of service degradation, 2:41005
STEAM TURBINES/WATER CHEMISTRY
Water chemistry conditions of saturated steam turbines (Water cooled reactors), 2:41479
STEARATES/ABSORPTION SPECTROSCOPY
Determination of lithium stearate in sebacate-based lubricants by atomic absorption, 2:41006
STEELS
See also CHROMIUM-MOLYBDENUM STEELS
NICKEL STEELS
STAINLESS STEELS
STEELS/CLADDING
Coal technology program progress report for February 1977, 2:40732 (ORNL/TM-5858)
STEELS/COATINGS
Electrodeposition of titanium diboride coatings. Report of investigations 1976 (4130 steel), 2:41816 (PB-257 384)
STEELS/CORROSION
Sea water corrosion. Volume 1. 1964-1975 (a bibliography with abstracts). Report for 1964-1975, 2:41815 (NTIS/PS-77/0052)
STEELS/ELASTICITY
Deep water laying of steel pipe-lines using free fall technique, 2:41047
STEELS/EMBRITTLEMENT
Indexing the degree of hydrogen embrittlement of 4340 steel using the barnacle electrode. Progress report, 2:41811 (AD-A-034661)
STEELS/FATIGUE
Effect of lubricant extreme-pressure additives on rolling-element fatigue life, 2:41010
STEELS/FRACTURE PROPERTIES
Determining fracture properties of reactor vessel forging materials, weldments, and bolting materials. Final report, 2:41783 (PB-257563)
Metallurgical factors controlling weld metal toughness in the seam welding of line pipe, 2:41758 (PB-256057)
STEELS/FRICTION
Boundary lubrication of formulated C-ethers in air to 300°C. II. Organic additives, 2:41001
STEELS/MECHANICAL PROPERTIES
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)
STEELS/PITTING CORROSION
Microbiological corrosion of tanks in long-term storage of gas oil, 2:41028
STEELS/PRODUCTION
Solving the coking coal problem, 2:40735
Uses of nuclear energy in metallurgy - research and development, 2:41452 (TRINEC-P-926)
STEELS/SLIDING FRICTION
Investigation of anti-wear additives under various loads and at different sliding speeds, 2:41003
STEELS/STRESSES
Deep water laying of steel pipe-lines using free fall technique, 2:41047
STEELS/SUBMERGED ARC WELDING
Metallurgical factors controlling weld metal toughness in the seam welding of line pipe, 2:41758 (PB-256057)
STEELS/TENSILE PROPERTIES
Coal technology program progress report for February 1977, 2:40732 (ORNL/TM-5858)
STEELS/THERMAL CONDUCTIVITY
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)
STEELS/WEAR
Boundary lubrication of formulated C-ethers in air to 300°C. II. Organic additives, 2:41001
STELLAR ATMOSPHERES/STRUCTURAL MODELS
Orbital changes of the gaseous ring around B/sub e/ stars (Theory to explain erratic V/R variations), 2:42156 (N-76-30126)
STELLARATORS
See also CLEO STELLARATOR
JIPP STELLARATOR
TORSATRON STELLARATOR
W STELLARATORS
WENDELSTEIN-7 STELLARATOR
STELLARATORS/EQUILIBRIUM PLASMA
Study of helical plasma equilibria, 2:42241
STELLARATORS/MINIMUM-B CONFIGURATIONS
Linked min.B configuration inside high shear magnetic surface, 2:42295 (N-76-25023)
STELLITE/STRESS CORROSION
Caustic stress corrosion cracking (LMFBR), 2:41388 (HEDL-SA-1122)
STIRLING ENGINES/DESIGN
Closed vapor cycle engine operated with trifluorethanol/ammonia as the working fluid (Patent), 2:41725
STONE METEORITES/CHEMICAL COMPOSITION
Cosmogenic radionuclides in stone meteorites, 2:42173 (N-76-25115)
STORAGE DEVICES (DATA)
See MEMORY DEVICES
STORAGE FACILITIES
See also NATURAL GAS
PETROLEUM

STORAGE FACILITIES/ENVIRONMENTAL IMPACTS
Strategic petroleum reserve. Draft environmental impact statement, 2:40996 (PB-255476)
STORAGE (SPENT FUEL)
See SPENT FUEL STORAGE
STRATIFIED CHARGE ENGINES/TECHNOLOGY ASSESSMENT
Study of stratified charge for light duty power plants. Volume I. Final report, 2:41716 (PB-256220)
Study of stratified charge for light duty power plants: Volume 3. Executive summary. Final report, 2:41717 (PB-256221)
STREAMING (RADIATION)
See RADIATION STREAMING
STREAMS/ECOLOGY
Decomposition in freshwater, 2:42004
STRONTIUM 90/BIOLOGICAL RADIATION EFFECTS
Annual report, fiscal year 1976, 2:42118 (UCD-472-123)
Clinical case load for radionuclide-treated beagles, calendar year 1975, 2:42088 (UCD-472-123)
STRONTIUM 90/HEALTH HAZARDS
Cumulative mortality in radionuclide treated beagles, 2:42089 (UCD-472-123)
STRONTIUM 90/RADIATION MONITORING
Appendix to health and safety laboratory environmental quarterly (Tabulated data on fallout radioactivity in environment), 2:41987 (HASL-318(App.))
STRONTIUM 90/RADIOISOTOPE HEAT SOURCES
Quarterly report on the strontium heat source development program and the beneficial isotopes utilization program, Division of Nuclear Research and Application for October-December 1976 (WESF capsules), 2:41155 (BNWL-1845-31)
STRONTIUM 90/TRANSMUTATION
Transmutation of strontium-90 and cesium-137 in a high-flux fast reactor with a thermalized central region, 2:41460
STRONTIUM ISOTOPES/SPECTRAL SHIFT
Isotopic shift between the even numbered Sr isotopes 84, 86, 88 and 90 and the jump in nuclear volume effect in the case of neutron count 50, 2:42203 (N-76-30045)
STYRENE/CHEMICAL RADIATION EFFECTS
Viscosity effects in the radiation-induced grafting of vinyl monomers on polyvinylchloride films. Technical report, 2:41878 (AD-A-026822)
SUBBITUMINOUS COAL/SORTING
Pneumatic classification of slack coal, 2:40903
SUBMARINES/ELECTRIC BATTERIES
Battery wedge for submarines or other installations, 2:41574 (AD-D-003275)
SUBSURFACE STRUCTURES/MECHANICAL VIBRATIONS
Influence of vibration parameters on the process of advancing a shield-type support, 2:40883
SUCROSE
See SACCHAROSE
SUDDEN IONOSPHERIC DISTURBANCE/TABLES
Solar-geophysical data number 387. Part I. Prompt reports. Data for October 1976-September 1976. Explanation of data reports issued as number 378 (supplement) February 1976, 2:42171 (PB-263008)
SULFATES/ENVIRONMENTAL TRANSPORT
Application of a lagrangian statistical trajectory model to the simulation of sulfur pollution over the northeastern United States, 2:41958 (ANL-75-60(Pt.4))
SULFATES/LABELLING
Synthesis of ^{13}N- and ^{35}S-labeled fossil fuel power plant effluents for in vivo distribution studies, 2:42125 (UCD-472-123)
SULFATES/MONITORING
National air sampling network. Status report, 2:41966 (PB-255288)
SULFATES/REDUCTION
Microbiological corrosion of tanks in long-term storage of gas oil, 2:41028
Microbiological corrosion of tanks in long-term storage of gas oil. II. Further bacterial studies and use of borax as a biocide, 2:41029
SULFATES/SPECTROSCOPY
Laser Raman spectrometric determination of oxy-anions in nuclear waste materials, 2:41868 (ARH-SA-279)
SULFHYDRYL COMPOUNDS
See THIOLS
SULFUR/ABSORPTION SPECTROSCOPY
Nature and distribution of sulphur compounds in Darius crude, 2:41017
SULFUR/CHEMICAL ANALYSIS
Coal I: current advances in coal chemistry and mining techniques (Book), 2:40834
SULFUR/DISTRIBUTION
Geomathematical prediction of sulphur in coal, New Lingan Mine area, Sydney coalfield, 2:40867
SULFUR/GAS CHROMATOGRAPHY
Use of a flame photometric detector for the analysis of coal sulfur (With 3940A filter which eliminates interferences), 2:40835
SULFUR/IODOMETRY
Determination of trace amounts of total sulfur in light petroleum distillates, 2:41018
SULFUR/PHOTOMETRY
Use of a flame photometric detector for the analysis of coal sulfur (With 3940A filter which eliminates interferences), 2:40835
SULFUR/POTENTIOMETRY
Nature and distribution of sulphur compounds in Darius crude, 2:41017
SULFUR/PRODUCTION
Utilization of low BTU gas from in-situ coal gasification for on-site power generation, 2:40773 (MERC/SP-76/3)
SULFUR/REMOVAL
Comparison of bottom-feed and top-feed reaction systems for hydrodesulphurization, 2:41058
Hydrocracking of residual oils and tars. V. Surface-coated cobalt molybdate catalysts for hydro-treating, 2:41063
Hydrodesulphurization of heavy gas-oils (650-975°F) derived from Athabasca bitumen, 2:41057
SULFUR/VOLTAMETRY
Coulometric micro-determination of sulphur and chloride in mineral oils, deposits, and solvent-extraction residues, 2:41019
Microcoulometric determination of sulphur at sub-ppm levels using the standby technique, 2:41020
SULFUR 38/LABELLED COMPOUNDS
Synthesis of ^{13}N- and ^{35}S-labeled fossil fuel power plant effluents for in vivo distribution studies, 2:42125 (UCD-472-123)
SULFUR COMPOUNDS/CHEMICAL REACTION KINETICS
Reaction kinetics of ozone with sulfur compounds. Final report, 2:41972 (PB-257891)
SULFUR COMPOUNDS/STABILITY
Thermal stability of sulfur compounds in heavy petroleum residual stocks, 2:40980
SULFUR DIOXIDE/ENVIRONMENTAL TRANSPORT
Application of a lagrangian statistical trajectory model to the simulation of sulfur pollution over the northeastern United States, 2:41958 (ANL-75-60(Pt.4))
Instrumental requirements for the measurement of pollutant fluxes (SO_2 and O_3 in surface air), 2:41960 (ANL-75-60(Pt.4))
SULFUR DIOXIDE/MEASURING METHODS
Value of stabilizers in the determination of sulphur dioxide in the air, 2:41984
SULFUR DIOXIDE/MONITORING
National air sampling network. Status report, 2:41966 (PB-255288)
SULFUR DIOXIDE/REMOVAL
Desulfurization of steel mill sinter plant gases. Final report, 2:41976 (PB-261922)
New tool combats SO_2 emissions, 2:40981
Shell flue gas desulfurization process: demonstration on oil- and coal-fired boilers, 2:40851
SULFUR DIOXIDE/SAMPLING
Regional air pollution study: quality assurance audits. Final report, 2:41967 (PB-255313)
SULFUR DIOXIDE/STANDARDS
Guideline for public reporting of daily air quality: Pollutant Standards Index (PSI). Final report, 2:41992 (PB-257892)
Standards support and environmental impact statement. Volume 1. Proposed standards of performance for petroleum refinery sulfur recovery plants, 2:41993 (PB-257975)
SULFUR HYDRIDES
See HYDROGEN SULFIDES
SULFUR OXIDES/INHALATION
Secondary aerosols from power plant effluents: delivery and in vivo detection systems (Tissue distribution of inhaled radioisotope-labelled $(NH_4)_2SO_4$ and NH_4NO_3 aerosols in monkeys), 2:42124 (UCD-472-123)
SULFUR OXIDES/TISSUE DISTRIBUTION
Secondary aerosols from power plant effluents: delivery and in vivo detection systems (Tissue distribution of inhaled radioisotope-labelled $(NH_4)_2SO_4$ and NH_4NO_3 aerosols in monkeys), 2:42124 (UCD-472-123)
SUN/BRIGHTNESS
Measures of the solar spectral irradiance between 1200 and 3000 a, 2:42169 (N-76-31126)
Rutgers zodiacal light experiment on OSO-6. Final report, 2:42168 (N-76-30257)
SUN/EXTREME ULTRAVIOLET RADIATION
Extreme solar ultraviolet monitor (ESUM) for atmosphere Explorer, 2:42166 (N-76-29361)
SUN/LUMINOSITY
Study of the relationship between solar activity and terrestrial weather, 2:42165 (N-76-28742)
SUN/ULTRAVIOLET SPECTRA
Measures of the solar spectral irradiance between 1200 and 3000 a, 2:42169 (N-76-31126)
SUPER HIGH FREQUENCY RADIATION
See RADIOWAVE RADIATION

SUPERCONDUCTING CABLES/COST
Superconducting power transmission: the perils and promise, 2:41299
SUPERCONDUCTING CABLES/DESIGN
Superconducting power transmission: the perils and promise, 2:41299
SUPERCONDUCTING CABLES/NEUTRON REACTIONS
DT fusion neutron irradiation of LLL "tritium-tricked" niobium, BNL-LASL superconductor wires, BPNL wire-foil packages, 2:42320 (UCID-17431)
SUPERCONDUCTING CABLES/SPECIFICATIONS
Superconducting power transmission: the perils and promise, 2:41299
SUPERCONDUCTING COILS/MECHANICAL PROPERTIES
Characterization of a superconducting coil composite and its components. Interim report, 2:41885 (PB-261709)
SUPERCONDUCTING MAGNETS
See also MAGNETIC ENERGY STORAGE
Superconducting lenses for high-voltage microscopy. Final report, 2:41884 (N-76-30534)
SUPERCONDUCTING MAGNETS/HEAT EXCHANGERS
Design of cryogenic heat exchangers for a superconducting magnet, 2:42296 (ORNL/MIT-242)
SUPERCONDUCTING MAGNETS/TOROIDAL CONFIGURATION
Full-size vacuum vessel and helical winding for the W VII Stellarator, 2:42297
SUPERCONDUCTIVITY/RESEARCH PROGRAMS
Theory of solid surfaces. Final scientific report 1 Oct 1972-30 Sep 1975, 2:42209 (AD-A-031022)
SUPERCONDUCTORS/RESEARCH PROGRAMS
Materials research at Stanford University. Annual report, 1 Jul 1975-30 Jun 1976, 2:41862 (N-76-30026)
SUPERCONDUCTORS/TECHNOLOGY ASSESSMENT
Superconductors, magnetic detectors and magnetic electronics. Final report, 2:42210 (AD-A-034361)
SUPERCONDUCTORS/TRANSITION TEMPERATURE
Gas anisotropy and T/sub c/ enhancement: general theory, and calculations for Nb, using Fermi surface harmonics, 2:41810
SUPERHEATERS/TUBES
Inelastic analysis of tubesheets by the finite element method (HTGR superheater), 2:41363
SUPERNOVA REMNANTS/INTERACTIONS
Hot interstellar tunnels. 1. Simulation of interacting supernova remnants, 2:42154 (N-76-29084)
SUPERNOVA REMNANTS/X-RAY SPECTRA
X-ray emission from the supernova remnant G287.8-0.5, 2:42157 (N-76-27135)
SUPERTANKERS
See TANKER SHIPS
SURFACE AIR
See also AIR
EARTH ATMOSPHERE
Preliminary look at the diurnal behavior of the PBL (Environmental transport of air pollutants), 2:41952 (ANL-75-60(Pt.4))
SURFACE AIR/AIR POLLUTION
Appendix to health and safety laboratory environmental quarterly (Tabulated data on fallout radioactivity in environment), 2:41987 (HASL-318(App.))
PBL scaling using surface flux information (Scales of similarity theory for the planetary boundary layer), 2:41953 (ANL-75-60(Pt.4))
Sangamon Experiment: geostrophic wind profiles (Direct measurement), 2:41954 (ANL-75-60(Pt.4))
SURFACE AIR/HEAT TRANSFER
Eddy-flux measurements at the Dresden cooling pond (Fluxes of heat and momentum above Dresden reactors cooling pond), 2:42014 (ANL-75-60(Pt.4))
Examination of some bulk formulae used for assessing the performance of industrial cooling ponds, 2:42001 (ANL-75-60(Pt.4))
Preliminary study of the relationship between surface and bulk water temperatures at the Dresden cooling pond, 2:42000 (ANL-75-60(Pt.4))
Preliminary tests of a model of cooling-pond thermal performance, 2:42002 (ANL-75-60(Pt.4))
SURFACE AIR/HUMIDITY
Structure of the urban moisture field (St. Louis urban area), 2:41957 (ANL-75-60(Pt.4))
SURFACE AIR/MIXING
Generalized Kolmogorov-von Karman relation and some further implications on the magnitude of the constants (Effects of wind sheer on atmospheric surface boundary layer), 2:41949 (ANL-75-60(Pt.4))
Sangamon Experiment: geostrophic wind profiles (Direct measurement), 2:41954 (ANL-75-60(Pt.4))
Structure of the urban moisture field (St. Louis urban area), 2:41957 (ANL-75-60(Pt.4))
SURFACE AIR/PRESSURE GRADIENTS
Sangamon Experiment: geostrophic wind profiles (Direct measurement), 2:41954 (ANL-75-60(Pt.4))
SURFACE AIR/RADIOACTIVITY
Appendix to health and safety laboratory environmental quarterly (Tabulated data on fallout radioactivity in environment), 2:41987 (HASL-318(App.))
SURFACE AIR/TEMPERATURE DISTRIBUTION
Pressure-sensitive release mechanism for radiosonde applications, 2:41956 (ANL-75-60(Pt.4))
Structure of the urban moisture field (St. Louis urban area), 2:41957 (ANL-75-60(Pt.4))
SURFACE AIR/TEMPERATURE MEASUREMENT
Sangamon Experiment: geostrophic wind profiles (Direct measurement), 2:41954 (ANL-75-60(Pt.4))
SURFACE AIR/TURBULENCE
Measurements of atmospheric turbidity in an arc downwind of St. Louis, 2:41955 (ANL-75-60(Pt.4))
SURFACE MINING/BIBLIOGRAPHIES
Coal mine waste (a bibliography with abstracts). Report for 1964-Nov 1976 (99 abstracts), 2:40870 (NTIS/PS-77/0040)
SURFACE MINING/ENVIRONMENTAL EFFECTS
Environmental impact of open pit mining in the conclusions of 'bergbau '76', 2:40863
Environmental aspects of coal production in the Appalachian Region. Progress report, June 1, 1976-May 31, 1977, 2:40871 (ORO-4946-2)
SURFACE MINING/LAND RECLAMATION
Contribution of ERTS-B to natural resource protection and recreational development in West Virginia. Progress report No. 3, 19 Mar-19 Jun 76, 2:40853 (E-76-10445)
Evaluation of surface mine reclamation techniques. Campbell's Run Watershed, Pennsylvania. Final report, Nov 1970-Oct 1975, 2:40857 (PB-255298)
Land Reclamation Program. Annual report, July 1975-July 1976, 2:40852 (ANL-76-XX-42)
SURFACE MINING/MATHEMATICAL MODELS
Environmental aspects of coal production in the Appalachian Region. Progress report, June 1, 1976-May 31, 1977, 2:40871 (ORO-4946-2)
SURFACE MINING/MINING EQUIPMENT
Concept feasibility study for training equipment to improve coal productivity. Volume I. Final report, 2:40876 (PB-254863)
Concept feasibility study for training equipment to improve coal productivity. Volume 2. Appendices. Final report, 2:40877 (PB-254864)
SURFACE PROPERTIES/RESEARCH PROGRAMS
Theory of solid surfaces. Final scientific report 1 Oct 1972-30 Sep 1975, 2:42209 (AD-A-031022)
SURFACE WATERS
See also COASTAL WATERS
ESTUARIES
LAKES
SEAS
STREAMS
SURFACE WATERS/CONTAMINATION
Evaluation of the limits of radioactive waste disposal into water systems of international importance, 2:41140 (IAEA-CN-36/346)
SURFACE WATERS/HEAT TRANSFER
Eddy-flux measurements at the Dresden cooling pond (Fluxes of heat and momentum above Dresden reactors cooling pond), 2:42014 (ANL-75-60(Pt.4))
Examination of some bulk formulae used for assessing the performance of industrial cooling ponds, 2:42001 (ANL-75-60(Pt.4))
Preliminary study of the relationship between surface and bulk water temperatures at the Dresden cooling pond, 2:42000 (ANL-75-60(Pt.4))
Preliminary tests of a model of cooling-pond thermal performance, 2:42002 (ANL-75-60(Pt.4))
SURFACE WATERS/SAMPLING
Trace element geochemistry of the South Atlantic Bight. Progress report, June 1, 1976-May 31, 1977, 2:42147 (SRO-890-2)
SWEDEN/DISTRICT HEATING
Reactor waste heat utilization and district heating reactors. Nuclear district heating in Sweden - Regional reject heat utilization schemes and small heat-only reactors, 2:41448 (IAEA-CN-36/275)
SWEDEN/NUCLEAR POWER
Energy policy and public acceptance, 2:41493 (IAEA-CN-36/588)
SWEDEN/RADIOACTIVE WASTE MANAGEMENT
Handling of waste at Swedish nuclear power plants, 2:41121 (IAEA-CN-36/282)
Management of radioactive waste and plutonium in the Swedish perspective, 2:41128 (IAEA-CN-36/554)
SYNTHESIS GAS
Prospects and problems for UCG in Britain (Methods of upgrading product), 2:40775 (MERC/SP-76/3)

SYNTHESIS GAS/CHARGES
Economics of manufacturing synthesis gas produced by underground coal gasification, 2:40757 (MERC/SP-76/3)
SYNTHESIS GAS/PRODUCTION
Assessment of very high-temperature reactors in process applications. Appendix III. Engineering evaluation of process heat applications for very-high temperature reactors, 2:40788 (ORNL/TM-5411)
Economics of manufacturing synthesis gas produced by underground coal gasification, 2:40757 (MERC/SP-76/3)
SYNTHETIC PETROLEUM/CHEMICAL COMPOSITION
Alternative liquid fuels and the ERDA program, 2:41639

T

TANKER SHIPS/ECONOMICS
SEASAT economic assessment. Volume 6: Arctic operations case study and generalization. Final report, Feb 1974-Aug 1975, 2:40995 (N-76-28619)
TANKER SHIPS/LEAK DETECTORS
Ammonia leakage test, 2:41041
TANKS/CORROSION PROTECTION
Microbiological corrosion of tanks in long-term storage of gas oil. II. Further bacterial studies and use of borax as a biocide, 2:41029
TANKS/SAFETY
Tank study committee report, 2:41888 (RFP-2639)
TANKS/WELDED JOINTS
Automatic welding for an LNG storage tank of 9% nickel steel, 2:41049
TANTALUM/DEUTERON REACTIONS
Proton sputtering. Final report (500 eV to 8 keV), 2:42318 (ORO-3557-15)
TANTALUM/PROTON REACTIONS
Proton sputtering. Final report (500 eV to 8 keV), 2:42318 (ORO-3557-15)
TANTALUM/SPUTTERING
Proton sputtering. Final report (500 eV to 8 keV), 2:42318 (ORO-3557-15)
TANTALUM ALLOYS
See also TANTALUM BASE ALLOYS
TANTALUM ALLOYS/COATINGS
Coatings for directional eutectics. Final report (NiCrAlCy coating for NiTaC-13), 2:41814 (N-76-29370)
TANTALUM ALLOYS/MELTING
M551 metals melting experiment, 2:41757 (N-76-27401)
TANTALUM ALLOYS/MICROSTRUCTURE
M551 metals melting experiment, 2:41757 (N-76-27401)
TANTALUM ALLOYS/OXIDATION
Coatings for directional eutectics. Final report (NiCrAlCy coating for NiTaC-13), 2:41814 (N-76-29370)
TANTALUM ALLOYS/WELDING
M551 metals melting experiment, 2:41757 (N-76-27401)
TANTALUM BASE ALLOYS/DEPOSITION
Sputter-deposition of metastable Ta-Pu, Ag-Pu and Co-Pu alloys, 2:41759
TANTALUM BASE ALLOYS/SPUTTERING
Sputter-deposition of metastable Ta-Pu, Ag-Pu and Co-Pu alloys, 2:41759
TAR
See also BITUMENS
COAL TAR
TAR/CATALYTIC CRACKING
Hydrocracking of residual oils and tars. II. The catalytic hydrocracking of Athabasca bitumen, 2:41060
TAR/HYDROCRACKING
Hydrocracking of residual oils and tars. I. The effect of feed dilution on the thermal hydrocracking of Athabasca bitumen, 2:41059
Hydrocracking of residual oils and tars. II. The catalytic hydrocracking of Athabasca bitumen, 2:41060
TAR SANDS
See OIL SANDS
TARAPUR-1 REACTOR/FUEL ELEMENTS
Integrated planning for a fuel industry with emphasis on minimum size to fabricate own fuel, 2:41086 (IAEA-CN-36/386)
TARGETS/NEUTRON REACTIONS
Calculations of the neutron emission spectra from materials bombarded with 14-mev neutrons, 2:42290
TECHNETIUM 99/SCINTISCANNING
Quantitation of ischemic and infarcted myocardium: relation between 99 Tc pyrophosphate and regional and total coronary blood flow, myocardial function and metabolism. Annual scientific report, 1 Jul 1975-31 Mar 1976, 2:42060 (PB-262160)
Scintiphotos in the diagnosis of renal allograft malfunction, 2:42061
TECHNETIUM ALLOYS/PHONONS
Phonon anomalies in transition metals, alloys, and compounds, 2:41809
TECHNETIUM ALLOYS/SUPERCONDUCTIVITY
Phonon anomalies in transition metals, alloys, and compounds, 2:41809
TECHNETIUM CARBIDES/PHASE DIAGRAMS
Some constitutional studies on uranium-carbon- and plutonium-carbon-rhenium and technetium systems, 2:41827
TELEVISION/RADIOACTIVITY
Biological effects of low levels of radiation exposure (Radiation hazards to man from radioactive consumer products), 2:42077 (UR-3490-1072)
TEMPERATURE MEASUREMENT
Thermoluminiminescent dosimeters (TLD's) used to monitor temperature exposure, 2:41937 (CONF-770201-2)
TENNESSEE/AIR QUALITY
Area source emission inventory: Hamilton County, Tennessee, and Walker and Catoosa Counties, Georgia. Volume I, 2:41973 (PB-258137)
Area source emission inventory: Hamilton County, Tennessee, and Walker and Catoosa Counties, Georgia. Volume II, 2:41974 (PB-258138)
TERBIUM PERCHLORATES/OSMOSIS
Isopiestic determination of the activity coefficients of some aqueous rare earth electrolyte solutions at 25°C. II. The rare earth perchlorates, 2:41874
TEST FACILITIES/DESIGN
Sodium-water reaction test facility (SWAT-3), 2:41548
TESTES/METABOLISM
Age and seasonal differences in the synthesis and metabolism of testosterone by testicular tissue and pineal HIOMT activity of Uinta ground squirrels (Spermophilus armatus), 2:42057
TESTES/PHYSIOLOGY
Contractility of rat testicular seminiferous tubules in vitro: prostaglandin F/sub lα/ and indomethacin, 2:42067
TESTOSTERONE/BIOSYNTHESIS
Age and seasonal differences in the synthesis and metabolism of testosterone by testicular tissue and pineal HIOMT activity of Uinta ground squirrels (Spermophilus armatus), 2:42057
TEXAS/INDUSTRIAL PLANTS
Changes in an electric utility's fuel base, 2:41653
TEXAS/IRRIGATION
Effect of changing input and product prices on the demand for irrigation water in Texas. Technical report, 2:41586 (PB-255731)
TEXAS/NUCLEAR POWER PLANTS
Changes in an electric utility's fuel base, 2:41653
TEXAS/PETROLEUM DEPOSITS
The potential and economics of enhanced oil recovery. Final report, 2:40932 (PB-254991)
TEXAS/PETROLEUM INDUSTRY
Changes in an electric utility's fuel base, 2:41653
TEXAS/PETROLEUM REFINERIES
Changes in an electric utility's fuel base, 2:41653
TEXAS/PUBLIC UTILITIES
Changes in an electric utility's fuel base, 2:41653
TEXAS/SCHOOL BUILDINGS
University of Houston student center, 2:41615 (NSF-RA-760006)
TFR TOKAMAK/CLUSTER BEAM INJECTION
Plasma heating by cluster injection: basic features and expected behaviour, 2:42213 (EUR-CEA-FC-848)
TFR TOKAMAK/LIMITERS
Use of limiters made of graphite and boron carbide in the TFR machine, 2:42316 (EUR-CEA-FC-852)
TFR TOKAMAK/PLASMA DIAGNOSTICS
Electron temperature and density relaxations during internal disruptions in TFR Tokamak plasmas, 2:42224 (EUR-CEA-FC-838)
TFTR DEVICE/NEUTRAL BEAM SOURCES
Neutral beam injector research and development work in the USA, 2:42302 (BNL-22436)
THERMAL DIFFUSIVITY
Effect of ground cover on Earth temperature, 2:41596 (NSF-RA-760006)
THERMAL EFFLUENTS/TEMPERATURE GRADIENTS
Stratified flows produced upon discharge of hot power-plant effluents into cooling ponds and rivers, 2:41498
THERMAL EFFLUENTS/USES
Evaluation of proposed man-made ponds for food production to recover values in waste heat and solid organic sludges. Completion report, 2:41699 (PB-258773)
THERMAL ENERGY STORAGE EQUIPMENT
Method and equipment to collect and store solar energy (Patent), 2:41218
THERMAL POLLUTION
(Environmental temperature rise due to waste heat disposal)

THERMAL POLLUTION/ENVIRONMENTAL EFFECTS
Simulation of spray canal cooling for power plants--performance and environmental effects, 2:41484
THERMAL POWER PLANTS
Thermoelectric power plants: a rational way of energy utilization in Europe, 2:41250
THERMAL POWER PLANTS/AIR POLLUTION
Determination of the feasibility of ozone formation in power plant plumes. Volume I. Executive summary, 2:41978 (PB-262092)
Determination of the feasibility of ozone formation in power plant plumes. Volume II. Final report, 2:41979 (PB-262093)
Determination of the feasibility of ozone formation in power plant plumes. Volume III. Data summary, 2:41980 (PB-262094)
Determination of the feasibility of ozone formation in power plant plumes. Volume IV. Data summary, 2:41981 (PB-262095)
Determination of the feasibility of ozone formation in power plant plumes. Volume V. Data summary, 2:41982 (PB-262096)
THERMAL POWER PLANTS/AIR POLLUTION CONTROL
Prevention of dust pollution from boilers, 2:41281
Technology and economics of flue gas NO/sub x/ oxidation by ozone. Final report, Jul-Oct 1976, 2:41975 (PB-261917)
THERMAL POWER PLANTS/COOLING SYSTEMS
Selected aspects of waste heat management: a state-of-the-art study. Final report, 2:41276 (PB-2556097)
Steam cooler plant for steam released for technological purposes, 2:41255
THERMAL POWER PLANTS/DESIGN
Systematic design strategies and process diagnostics for power plants, 2:41249
THERMAL POWER PLANTS/ECONOMETRICS
Models for analyzing and forecasting economic characteristics of steam power plants, 2:41275
THERMAL POWER PLANTS/GAS TURBINES
Prospects of development of gas turbine installations in the USSR, 2:41267
Some specific features of the calculation of the reliability indices of peak gas turbine power plants, 2:41272
Tests of the gas turbine plant gt-100-750-2 using liquid fuel, 2:41268
THERMAL POWER PLANTS/HEAT STORAGE
Method of utilizing the excess heat of an electricity generating plant (Patent), 2:41273
THERMAL POWER PLANTS/REFUSE DERIVED FUELS
Markets and technology for recovering energy from solid waste, 2:41259 (PB-253326)
Power from urban refuse, 2:41260
THERMAL POWER PLANTS/SITE SELECTION
Economics of power plant siting in southeastern New England. Final report, 2:41283 (PB-254743)
THERMAL POWER PLANTS/START-UP
Some features of organization of starting conditions of the 300 MW monoblock, 2:41258
THERMAL POWER PLANTS/STEAM GENERATORS
Thermal and temperature regimes of the experimental membrane waterwall of the PK-41 steam generator, 2:41270
THERMAL POWER PLANTS/STEAM TURBINES
Comparative measurements on large steam turbines, 2:41265
THERMAL POWER PLANTS/TECHNOLOGY ASSESSMENT
Study of inplant electric power generation in the chemical, petroleum refining, and paper and pulp industries. Final report, 2:41247 (PB-255659)
THERMAL POWER PLANTS/THERMAL EFFLUENTS
Selected aspects of waste heat management. Summary report, 2:41254 (PB-254401)
Selected aspects of waste heat management: a state-of-the-art study. Final report, 2:41276 (PB-2556097)
THERMAL POWER PLANTS/TUBES
Power plant tubing--a critical review, 2:41262
THERMIONIC CONVERSION
Thermionic conversion (Basic principles; proposed solar and nuclear reactor heat sources), 2:41662
THERMIONIC CONVERTERS
Thermionic conversion (Basic principles; proposed solar and nuclear reactor heat sources), 2:41662
THERMIONIC REACTORS/POWER CONDITIONING CIRCUITS
Electric power-conditioning for a thermionic generator (Space satellite thermionic reactor), 2:41428
THERMODYNAMIC CYCLES/EFFICIENCY
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
THERMOELECTRIC GENERATORS/DESIGN
Nuclear powered satellite design for shuttle launches, 2:41157
THERMOELECTRIC GENERATORS/RADIOISOTOPE HEAT SOURCES
Fracture behavior of a Pt-30% Rh-8% W alloy between room temperature and 1300°c, 2:41156
THERMOLUMINESCENT DOSEMETERS
Thermolumiminescent dosimeters (TLD's) used to monitor temperature exposure, 2:41937 (CONF-770201-2)
THERMONUCLEAR FUELS
Advanced fuels for inertial confinement, 2:41152
THERMONUCLEAR FUELS/COATINGS
Electroless or autocatalytic coating of microparticles for laser fusion targets, 2:41147 (LA-6583)
Electrolytic coating of microparticles for laser fusion targets, 2:41148 (LA-6584)
Recent developments in laser-fusion target coatings, 2:41149 (LA-UR-75-2053)
THERMONUCLEAR FUELS/CONTAINMENT SHELLS
Container for fusion fuel (Patent), 2:42304
THERMONUCLEAR FUELS/ELECTROPLATING
Electrolytic coating of microparticles for laser fusion targets, 2:41148 (LA-6584)
THERMONUCLEAR FUELS/FABRICATION
Electroless or autocatalytic coating of microparticles for laser fusion targets, 2:41147 (LA-6583)
Fusion fuel pellet and method for its fabrication (Patent), 2:41153
Recent developments in laser-fusion target coatings, 2:41149 (LA-UR-75-2053)
Thermonuclear fuel and its preparation process (Patent), 2:41151
Thermonuclear fuel and preparation process (Patent), 2:41150
THERMONUCLEAR REACTOR MATERIALS/MATERIALS TESTING
DT fusion neutron irradiation of LLL "tritium-tricked" niobium, BNL-LASL superconductor wires, BPNL wire-foil packages, 2:42320 (UCID-17431)
THERMONUCLEAR REACTOR MATERIALS/MECHANICAL PROPERTIES
Estimate of low-Z materials for the first wall of JT-60, 2:42317 (JAERI-M-6432)
THERMONUCLEAR REACTOR MATERIALS/NEUTRON REACTIONS
DT fusion neutron irradiation of LLL "tritium-tricked" niobium, BNL-LASL superconductor wires, BPNL wire-foil packages, 2:42320 (UCID-17431)
THERMONUCLEAR REACTOR MATERIALS/PHYSICAL PROPERTIES
Estimate of low-Z materials for the first wall of JT-60, 2:42317 (JAERI-M-6432)
THERMONUCLEAR REACTOR MATERIALS/RESEARCH PROGRAMS
Fusion power program. Quarterly progress report, October-December 1976, 2:42314 (ANL/FPP-76-6)
THERMONUCLEAR REACTOR WALLS/RADIOACTIVATION
Low activation materials assessment for fusion reactors, 2:42315 (EPRI-ER-328-SR)
THERMONUCLEAR REACTORS
(For use in cases where certain aspects of either hypothetical or real thermonuclear reactors are discussed.)
See also E-BEAM TYPE REACTORS
LASER FUSION REACTORS
MAGNETIC MIRROR TYPE REACTORS
REFERENCE THETA PINCH REACTOR
THERMONUCLEAR REACTOR WALLS
TOKAMAK TYPE REACTORS
Concept of a fusion burner, 2:42281
THERMONUCLEAR REACTORS/CONTROL SYSTEMS
Reactor control system by means of neutral-beam injection, 2:42321
THERMONUCLEAR REACTORS/ENERGY BALANCE
Preliminary study on power balance in the plasma of an experimental fusion reactor, 2:42285 (JAERI-M-6453)
THERMONUCLEAR REACTORS/FORECASTING
Prospects and technical problems of nuclear fusion, 2:42274
THERMONUCLEAR REACTORS/LASER-PRODUCED PLASMA
Filling of toroidal traps with laser plasmas, 2:42301 (AED-Conf-76-506-003)
THERMONUCLEAR REACTORS/NEUTRAL ATOM BEAM INJECTION
Reactor control system by means of neutral-beam injection, 2:42321
THERMONUCLEAR REACTORS/POWER SUPPLIES
Results of experiments with a superconductive prototype coil for a toroidal magnet, 2:42300
THERMONUCLEAR REACTORS/RESEARCH PROGRAMS
Annual report of the Division of Thermonuclear Fusion Research, JAERI. Covering the period of April 1, 1974 to March 31, 1975, 2:42275 (JAERI-M-6359)
THERMONUCLEAR WEAPONS
See NUCLEAR WEAPONS
THIO COMPOUNDS
See ORGANIC SULFUR COMPOUNDS

THIOLS/ABSORPTION SPECTROSCOPY
Nature and distribution of sulphur compounds in Darius crude, 2:41017
THIOLS/POTENTIOMETRY
Nature and distribution of sulphur compounds in Darius crude, 2:41017
THIOPHOSPHORIC ACID ESTERS/ACTIVATION ANALYSIS
Preferential adsorption in the lubrication process of zinc dialkyldithiophosphate, 2:41009
THIOPHOSPHORIC ACID ESTERS/CHROMATOGRAPHY
Preferential adsorption in the lubrication process of zinc dialkyldithiophosphate, 2:41009
THORIUM/ELECTRONIC STRUCTURE
Electronic energy band structure of actinide metals and intermetallics, 2:41772
THORIUM CARBIDES/KNIGHT SHIFT
Nuclear magnetic resonance of carbon 13 and nitrogen 15 in uranium and thorium carbonitrides, 2:41824
THORIUM CARBIDES/ORDER PARAMETERS
Study of atomic short-range order in nonstoichiometric actinide carbides by diffuse neutron scattering, 2:41832
THORIUM CARBIDES/PHYSICAL RADIATION EFFECTS
HTGR fuels and core development program. Quarterly progress report for the period ending February 28, 1977, 2:41355 (GA-A-14298)
THORIUM CARBIDES/SPIN-LATTICE RELAXATION
Nuclear magnetic resonance of carbon 13 and nitrogen 15 in uranium and thorium carbonitrides, 2:41824
THORIUM NITRIDES/KNIGHT SHIFT
Nuclear magnetic resonance of carbon 13 and nitrogen 15 in uranium and thorium carbonitrides, 2:41824
THORIUM NITRIDES/SPIN-LATTICE RELAXATION
Nuclear magnetic resonance of carbon 13 and nitrogen 15 in uranium and thorium carbonitrides, 2:41824
THORIUM OXIDES/CHEMICAL BONDS
Electronic properties of actinide oxides, 2:41829
THORIUM OXIDES/CRYSTAL FIELD
Ab initio calculations of the crystal field splittings for Np^{3+} centers in CaF_2 (as well as for selected other complexes) by molecular orbital techniques, 2:41823
THORIUM OXIDES/LATTICE PARAMETERS
Low temperature lattice parameters of the actinide dioxides, 2:41830
THORIUM OXIDES/MOLECULAR ORBITAL METHOD
Ab initio calculations of the crystal field splittings for Np^{3+} centers in CaF_2 (as well as for selected other complexes) by molecular orbital techniques, 2:41823
THORIUM OXIDES/PHYSICAL RADIATION EFFECTS
HTGR fuels and core development program. Quarterly progress report for the period ending February 28, 1977, 2:41355 (GA-A-14298)
Lattice defects and irradiation damage in ThO_2, UO_2 and $(U,Pu)O_2$, 2:41854
THORIUM OXIDES/REPROCESSING
Thorium utilization program. Quarterly progress report for the period ending February 28, 1977, 2:41093 (GA-A-14304)
THORIUM SULFIDES/ELECTRONIC STRUCTURE
Electronic structure of mixed uranium-thorium monochalcogenides, 2:41864
THORIUM TELLURIDES/CRYSTAL STRUCTURE
Electronic structure of mixed uranium-thorium monochalcogenides, 2:41864
THREE MILE ISLAND-1 REACTOR/RADIOACTIVE WASTE PROCESSING
Radwaste treatment study for a once through steam generator cleaning solution, 2:41348
THREE MILE ISLAND-2 REACTOR/RADIOACTIVE WASTE PROCESSING
Radwaste treatment study for a once through steam generator cleaning solution, 2:41348
THTR-300 REACTOR/CONSTRUCTION
Directors' report, 1975, 2:41352 (DEU-76-38)
THTR-300 REACTOR/REACTOR SAFETY
Safety analysis of the THTR-300 MW(e)-prototype-reactor and future HTR's under extreme accident conditions, 2:41528 (IAEA-CN-36/560)
THULIUM PERCHLORATES/OSMOSIS
Isopiestic determination of the activity coefficients of some aqueous rare earth electrolyte solutions at 25°C. II. The rare earth perchlorates, 2:41874
THYMOCYTES/RADIOSENSITIVITY
Analysis of the developmental stage of specific and nonspecific cytotoxicity. I. Separation of the developmental steps of specific cytotoxicity by susceptibility to irradiation (X Radiation, mice), 2:42073
THYROID/PHYSIOLOGY
Age-related changes in thyroid function in beagle pups, 2:42066 (UCD-472-123)
THYROID/RETENTION FUNCTIONS
Dose limitations to humans from ^{129}I, 2:42086 (UCD-472-123)
Metabolism of ^{129}I in young beagles, 2:42092 (UCD-472-123)
TID
See TRAVELLING IONOSPHERIC DISTURBANCE
TIHANGE REACTOR
Nuclear power plant of Tihange, 2:41338
TIN/ABSORPTION SPECTROSCOPY
Determination of trace metals in crude oils by nonflame atomic absorption spectroscopy, 2:41014
TIN ALLOYS/MECHANICAL PROPERTIES
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)
TIN ALLOYS/THERMAL CONDUCTIVITY
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)
TIN SULFIDES/PHONONS
Inelastic neutron scattering studies of the phonon spectra of Chevrel phase superconductors ($SnMo_6S_8$, $PbMo_6S_8$, Mo_6Se_8, $Pb_{1-x}Mo_6Se_8$), 2:41808
TIN SULFIDES/SUPERCONDUCTIVITY
Inelastic neutron scattering studies of the phonon spectra of Chevrel phase superconductors ($SnMo_6S_8$, $PbMo_6S_8$, Mo_6Se_8, $Pb_{1-x}Mo_6Se_8$), 2:41808
TIRES/ROLLING FRICTION
The influence of tire geometry on the rolling efficiency of commercial vehicle tires. Interim report, 2:41688 (PB-262348)
TITANIUM/RADIOACTIVATION
Low activation materials assessment for fusion reactors, 2:42315 (EPRI-ER-328-SR)
TITANIUM ALLOYS
See also TITANIUM BASE ALLOYS
TITANIUM ALLOYS/MECHANICAL PROPERTIES
Semi-annual report on materials research in support of superconducting machinery. Final report (Composite materials), 2:41784 (PB-261996)
TITANIUM ALLOYS/SOLID SOLUTIONS
Splat cooling of some actinide alloys, 2:41760
TITANIUM ALLOYS/SPLAT COOLING
Splat cooling of some actinide alloys, 2:41760
TITANIUM ALLOYS/THERMAL CONDUCTIVITY
Semi-annual report on materials research in support of superconducting machinery. Final report (Composite materials), 2:41784 (PB-261996)
TITANIUM BASE ALLOYS/FORGING
High-toughness titanium alloy development. Final engineering report Jan 1975-May 1976, 2:41756 (AD-A-030274)
TITANIUM BASE ALLOYS/HEAT TREATMENTS
High-toughness titanium alloy development. Final engineering report Jan 1975-May 1976, 2:41756 (AD-A-030274)
TITANIUM BASE ALLOYS/MECHANICAL PROPERTIES
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)
TITANIUM BASE ALLOYS/THERMAL CONDUCTIVITY
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)
TITANIUM BORIDES/ELECTRODEPOSITION
Electrodeposition of titanium diboride coatings. Report of investigations 1976, 2:41816 (PB-257 384)
TITANIUM OXIDES/SOLUBILITY
Lung clearance of particles (TiO_2 tracer study), 2:42128
TOBACCO/CHEMICAL ANALYSIS
Naturally occurring nitrosatable amines. II. Secondary amines in tobacco and cigarette smoke condensate, 2:41867
TOBACCO/SOLAR DRYING
Solar energy applications in agriculture: potential, research needs, and adoption strategies, summary and recommendations, 2:41217 (PB-255928)
TOBACCO SMOKES/CHEMICAL ANALYSIS
Naturally occurring nitrosatable amines. II. Secondary amines in tobacco and cigarette smoke condensate, 2:41867
TOKAMAK DEVICES
See also ATC DEVICES
DOUBLET-3 DEVICE
PETULA TOKAMAK
PLT DEVICES
TFR TOKAMAK
TFTR DEVICE
TOKAMAK DEVICES/ECR HEATING
Plasma heating in the TM-3 Tokamak at the electron cyclotron resonance in magnetic fields up to 25kGs, 2:42214 (EUR-CEA-FC-855-TR)
TOKAMAK DEVICES/FORECASTING
Prospects and technical problems of nuclear fusion, 2:42274
TOKAMAK DEVICES/IMPURITIES
Neutrals and impurities in the Tokamak discharges, 2:42233 (AED-Conf-76-506-002)

TOKAMAK DEVICES/MAGNET COILS
Optimum design of the poloidal field coils of a large fusion device, 2:42292 (JAERI-M-6451)
TOKAMAK DEVICES/MAGNETIC FIELD CONFIGURATIONS
Computer code for study of the error magnetic fields based on a model of practical poloidal field coils in a large tokamak, 2:42293 (JAERI-M-6470)
TOKAMAK DEVICES/NEUTRAL PARTICLES
Neutrals and impurities in the Tokamak discharges, 2:42233 (AED-Conf-76-506-002)
TOKAMAK DEVICES/PLASMA DIAGNOSTICS
Study of far-infrared Michelson interferometry based on fast plasma scanning, 2:42228
TOKAMAK DEVICES/PLASMA WAVES
Propagation characteristics of cold lower hybrid waves in linear tokamak plasmas, 2:42270
RF coupling and mode conversions at the lower hybrid resonance, 2:42269
TOKAMAK DEVICES/POWER SUPPLIES
Power supply to the air-core transformer coils of a large tokamak by a multi-stage inductive energy storage system. Optimal design of the electric circuits by a simplex method, 2:42303 (JAERI-M-6467)
TOKAMAK DEVICES/RUNAWAY ELECTRONS
Synchrotron radiation of runaway electrons in the TM-3 TOKAMAC, 2:42288
TOKAMAK DEVICES/SYNCHROTRON RADIATION
Synchrotron radiation of runaway electrons in the TM-3 TOKAMAC, 2:42288
TOKAMAK TYPE REACTORS/CYCLOTRON INSTABILITY
Plasma thermonuclear cyclotron-magnetoacoustic instability, 2:42248
TOKAMAK TYPE REACTORS/DESIGN
Conclusions from the Oak Ridge EPR studies and initiation of the TNS program. A brief summary, 2:42278 (ORNL-5278)
ORNL-EPR study--results and implications, 2:42291
TOKAMAK TYPE REACTORS/PLANNING
Basic plasma parameters of an experimental fusion reactor. First preliminary design, 2:42276 (JAERI-M-6484)
Conclusions from the Oak Ridge EPR studies and initiation of the TNS program. A brief summary, 2:42278 (ORNL-5278)
TOKAMAK TYPE REACTORS/RADIATION STREAMING
Evaluation of neutron streaming through injection ports in a tokamak-type fusion reactor, 2:42286 (JAERI-M-6475)
TOKAMAK TYPE REACTORS/TRAPPED-PARTICLE INSTABILITY
Nonlinear saturation of the dissipative trapped-electron instability, 2:42246 (PPPL-1337)
TOPPING CYCLES
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
Coal technology program progress report for January 1977, 2:40731 (ORNL/TM-5819)
TORNADO DEVICES/NEUTRON EMISSION
Data on rotating plasma operation in Tornado traps, 2:42322
TORNADOES
Numerical simulation of tornado-borne missile impact on fuel reprocessing and fabrication plants, 2:41881 (UCRL-52223)
TOROIDAL PINCH DEVICES/REVIEWS
Toroidal Z-pinch demonstration, 2:42277 (LASL-77-3)
TOROIDAL SCREW PINCH DEVICES/MAGNETIC ENERGY STORAGE
Magnetic energy storage system used in ZT-1, 2:42299
TOROIDAL SCREW PINCH DEVICES/PLASMA MACROINSTABILITIES
Macroscopic oscillation and deformation of the plasma in SPICA, 2:42247 (Rijnhuizen-76-99)
TORSATRON STELLARATOR/PLASMA CONFINEMENT
Confinement studies in Culham stellarators with ohmic heating currents, 2:42211 (AED-Conf-76-506-008)
TORUS-II TOKAMAK/DESIGN
Columbia Torus II design report (Mechanical and electrical properties), 2:42273 (COO-2456-41)
TOTAL ENERGY SYSTEMS
See also MIUS
TOTAL ENERGY SYSTEMS/ENVIRONMENTAL IMPACTS
Solar program assessment: environmental factors (Analysis based on system of 1000 single-family residences), 2:41180 (ERDA-77-47/5)
TOTAL ENERGY SYSTEMS/FEASIBILITY STUDIES
Consultant's approach to total energy, 2:41667
TOWER FOCUS POWER PLANTS/CENTRAL RECEIVERS
Closed cycle, high-temperature central receiver concept for solar electric power, 2:41202 (PB-254399)
TOWER FOCUS POWER PLANTS/HEAT EXCHANGERS
Heat pipe central solar receiver. Semiannual progress report, March 1, 1976-August 31, 1976, 2:41201 (COO/2839-1)
TRAINS
See also ELECTRIC RAILWAYS
LEVITATED TRAINS
TRAINS/RESEARCH PROGRAMS
Energy savings resulting from modal shifts to Corridorrail, 2:41739 (PB-257409)
TRANSAMINASES
See AMINOTRANSFERASES
TRANSFORMERS/DESIGN
Static convertor transformers for the hvdc transmission link Cabora Bassa-Apollo, 2:41298
Transformers manufactured in brazil, 2:41286
TRANSFORMERS/PERFORMANCE
Service experience with distribution transformers without oil conservators, 2:41288
TRANSFORMERS/REVIEWS
Survey of high-output transformers and a look at possible future developments, 2:41285
TRANSFORMERS/STANDARDIZATION
Standard transformers for 2 to 100 MVA, 2:41287
TRANSITION ELEMENT ALLOYS/LAVES PHASES
Theory of solid surfaces. Final scientific report 1 Oct 1972-30 Sep 1975, 2:42209 (AD-A-031022)
TRANSITION ELEMENT ALLOYS/MAGNETOSTRICTION
Rare Earth-transition metal magnetostrictive materials. Progress report, 2:41795 (AD-A-030791)
TRANSITION ELEMENT ALLOYS/PHONONS
Phonon anomalies in transition metals, alloys, and compounds, 2:41809
TRANSITION ELEMENT ALLOYS/SUPERCONDUCTIVITY
Phonon anomalies in transition metals, alloys, and compounds, 2:41809
TRANSITION ELEMENT COMPOUNDS/PHONONS
Phonon anomalies in transition metals, alloys, and compounds, 2:41809
TRANSITION ELEMENT COMPOUNDS/SUPERCONDUCTIVITY
Phonon anomalies in transition metals, alloys, and compounds, 2:41809
TRANSITION ELEMENTS/ACTIVATION ANALYSIS
Mode of occurrence of trace elements in petroleum and relationship to oil-spill identification methods, 2:41027
TRANSITION ELEMENTS/PHONONS
Phonon anomalies in transition metals, alloys, and compounds, 2:41809
TRANSITION ELEMENTS/SUPERCONDUCTIVITY
Phonon anomalies in transition metals, alloys, and compounds, 2:41809
TRANSPORT
(Limited to the movement of goods and persons.)
See also MARINE TRANSPORT
TRANSPORT/ENERGY MODELS
Modeling the economic and environmental consequences of alternative energy policies (SEAS: Strategic Environmental Assessment System), 2:41599
TRANSPORTABLE REACTORS
(Capable of being moved when not critical and possibly partly dismantled.)
TRANSPORTABLE REACTORS/FEASIBILITY STUDIES
Mobile nuclear power plants: initial feasibility study. Research report (Transportable plants for industrial energy), 2:41427 (PB-258232)
TRANSPORTATION SYSTEMS
See also RAPID TRANSIT SYSTEMS
TRANSPORTATION SYSTEMS/COST BENEFIT ANALYSIS
Risk analysis and transportation planning, 2:41704
TRANSPORTATION SYSTEMS/DESIGN
System analysis, design, and operation of automated guideway transit systems, 2:41707
Use of simulation in the design of a dial-a-ride system, 2:41709
TRANSPORTATION SYSTEMS/ELECTRIC-POWERED VEHICLES
Battery-electric road transport as part of an aggregate transport system, 2:41732
TRANSPORTATION SYSTEMS/ENERGY CONSUMPTION
Assessing the relationship between urban form and travel requirements: a literature review and conceptual framework. Research report, 2:41687 (PB-254988)
Urban goods movement demonstration project design phases I and II. Executive summary, 2:41679 (PB-254854)
TRANSPORTATION SYSTEMS/FEASIBILITY STUDIES
Suburb-to-suburb intercity travel: energy, time and dollar expenditures, 2:41737 (N-76-29064)
TRANSPORTATION SYSTEMS/MATHEMATICAL MODELS
Macroanalysis of the implications of major modal shifts in integrated regional transportation networks. Final report on phase I, 2:41701 (PB-256136)

Macroanalysis of the implications of major modal shifts in integrated regional transportation networks. Phase I: appendices. Final report, 2:41702 (PB-256137)
Risk analysis and transportation planning, 2:41704
TRANSPORTATION SYSTEMS/OPERATION
Bus priority system simulator (Traffic signal system giving priority to buses), 2:41706
Simulating an urban jitney system, 2:41708
System analysis, design, and operation of automated guideway transit systems, 2:41707
TRANSPORTATION SYSTEMS/PERFORMANCE
Use of simulation in the design of a dial-a-ride system, 2:41709
TRANSPORTATION SYSTEMS/PLANNING
Macroanalysis of the implications of major modal shifts in integrated regional transportation networks. Final summary report on phase 1, 2:41686 (PB-254923)
Risk analysis and transportation planning, 2:41704
UCOST: a planning, scheduling, and costing system, 2:41703
TRANSPORTATION SYSTEMS/REGIONAL ANALYSIS
Macroanalysis of the implications of major modal shifts in integrated regional transportation networks. Final summary report on phase 1, 2:41686 (PB-254923)
TRANSPORTATION SYSTEMS/SIMULATION
Simulating an urban jitney system, 2:41708
Use of simulation in the design of a dial-a-ride system, 2:41709
TRANSPORTATION SYSTEMS/SYSTEMS ANALYSIS
System analysis, design, and operation of automated guideway transit systems, 2:41707
TRANSURANIUM ELEMENTS
See also NEPTUNIUM
PLUTONIUM
TRANSURANIUM ELEMENTS/BODY BURDEN
Summary of discussion calibration techniques and errors I, 2:42100 (BNWL-2088)
TRANSURANIUM ELEMENTS/TISSUE DISTRIBUTION
Determination of heavy elements in humans, 2:42099 (BNWL-2088)
Error analysis and propagation of uncertainties for the measurement of inhaled transuranium elements, 2:42098 (BNWL-2088)
Summary of discussion calibration techniques and errors I, 2:42100 (BNWL-2088)
Ultrasonic measurement techniques used at LLL for determining chest wall thickness and organ shapes (Monitoring personnel for transuranic element deposition in lungs), 2:42112 (BNWL-2088)
TRAPPED-PARTICLE INSTABILITY
Nonlinear saturation of the dissipative trapped-electron instability, 2:42246 (PPPL-1337)
TRAPPED-PARTICLE INSTABILITY/COUPLING
Non-linear saturation of the dissipative trapped-ion mode by mode coupling, 2:42250
TRAPPED-PARTICLE INSTABILITY/DIFFUSION
Anomalous diffusion of alpha particles in the non-linear trapped-ion regime, 2:42251
TRAVELLING IONOSPHERIC DISTURBANCE/WAVE PROPAGATION
ATS-6 40- and 360-MHz differential phase measurements. Environmental research papers, 2:42176 (AD-A-030739)
TRITIUM/CLEARANCE
Methylmercury movements across the perfused guinea pig placenta in late gestation, 2:42058
TRITIUM/CONTAINMENT
Fusion power program. Quarterly progress report, October-December 1976, 2:42314 (ANL/FPP-76-6)
TRITIUM/REMOVAL
Tritium formation and elimination in light-water electronuclear plants, 2:41497 (IAEA-CN-36/238)
TROUT/TEMPERATURE EFFECTS
Use of a cold-water refuge by rainbow and brown trout in a geothermally heated stream, 2:42115
TRUCKS/AERODYNAMICS
Study of aerodynamic drag reduction on a full-scale tractor-trailer. Final report, Mar-Dec 1974, 2:41741 (PB-254571)
TRUCKS/FUEL CONSUMPTION
The influence of tire geometry on the rolling efficiency of commercial vehicle tires. Interim report, 2:41688 (PB-262348)
TRUCKS/FUEL ECONOMY
Quarterly Bulletin of the Division of Mechanical Engineering and the National Aeronautical Establishment, Ottawa, 1 July to 30 September 1976, 2:41710 (AD-A-034552)
Research plan for achieving reduced automotive energy consumption, 2:41711 (PB-255929)
TRUCKS/TIRES
The influence of tire geometry on the rolling efficiency of commercial vehicle tires. Interim report, 2:41688 (PB-262348)
TUBES
(For objects of tubular shape; not for DRIFT TUBES, ELECTRON TUBES or IMAGE STORAGE TUBES.)
See also BAFFLED TUBES
TUBES/CREEP
Inelastic analysis of tubesheets by the finite element method (HTGR superheater), 2:41363
TUBES/MECHANICAL VIBRATIONS
Mathematical model for cross-flow-induced vibrations of tube rows, 2:41920
TUBES/PLASTICITY
Inelastic analysis of tubesheets by the finite element method (HTGR superheater), 2:41363
TUBES (CONDUITS)
See PIPES
TUMOR CELLS/COMPARATIVE EVALUATIONS
Human cord blood lymphocytes. Ultrastructural and immunologic surface marker characteristics: a comparison with B- and T-cell lymphomas, 2:42041
TUMOR CELLS/IMMUNE REACTIONS
Analysis of the developmental stage of specific and nonspecific cytotoxicity. I. Separation of the developmental steps of specific cytotoxicity by susceptibility to irradiation (X Radiation, mice), 2:42073
Immunogenic and antigenic properties of a rat Moloney sarcoma, 2:42056
TUMOR VIRUSES
See ONCOGENIC VIRUSES
TUMORS
See NEOPLASMS
TUNGSTEN/DEUTERON REACTIONS
Proton sputtering. Final report (500 eV to 8 keV), 2:42318 (ORO-3557-15)
TUNGSTEN/PROTON REACTIONS
Proton sputtering. Final report (500 eV to 8 keV), 2:42318 (ORO-3557-15)
TUNGSTEN/SPUTTERING
Proton sputtering. Final report (500 eV to 8 keV), 2:42318 (ORO-3557-15)
TUNGSTEN/TENSILE PROPERTIES
Tensile behavior of unnotched and notched tungsten-copper laminar composites, 2:41782 (N-76-26287)
TUNGSTEN ALLOYS
See also STELLITE
TUNGSTEN BASE ALLOYS
TUNGSTEN ALLOYS/FRACTURE PROPERTIES
Fracture behavior of a Pt-30% Rh-8% W alloy between room temperature and 1300°c, 2:41156
TUNGSTEN ALLOYS/WEAR
Durability of tungsten-cobalt carbide alloys, 2:41785 (N-76-28369)
TUNGSTEN BASE ALLOYS/FRACTURE PROPERTIES
Nonlinear compliance curves caused by crack closure in fracture tests of tungsten alloy, 2:41786
TUNNELS/CONSTRUCTION
Utilities for underground structures (Austin, Texas, Crosstown Interceptor Tunnel), 2:41590 (NSF-RA-760006)
TUNNELS/DESIGN
Preliminary engineering and economic evaluation of underspoil haulage in area strip coal mines. Part I. Summary report, 27 Jun-10 Oct 1975, 2:40874 (PB-254575)
TURBINE BLADES/CREEP
Coal technology program quarterly progress report for the period ending December 31, 1976, 2:40729 (ORNL-5252)
TURBINES
See also GAS TURBINES
STEAM TURBINES
TURBINES/BEARINGS
Bearing application of quick running rotors, particularly of waste gas superchargers (Patent), 2:41882
TURBINES/ENERGY LOSSES
Bearing application of quick running rotors, particularly of waste gas superchargers (Patent), 2:41882
TURBOMACHINERY
See also PUMPS
TURBINES
TURBOMACHINERY/DESIGN
Possible use of expansion turbines in gas and petroleum industries, 2:40947
TURBOMACHINERY/USES
Possible use of expansion turbines in gas and petroleum industries, 2:40947
TURNOVER (RADIONUCLIDES)
See RADIONUCLIDE KINETICS
TWO-PHASE FLOW
Summary on experimental methods for statistical transient analysis of two-phase gas-liquid flow (BWR, PWR, and LMFBR), 2:41312 (ANL-76-75)
TWO-PHASE FLOW/HEAT TRANSFER
Heat transfer in the entrance section of a pipe with a two-phase flow, 2:41918

TWO-PHASE FLOW/MATHEMATICAL MODELS
A review of the rational approach to two-phase flow modeling. Topical report, 2:41457 (PB-255548)
TWO-STREAM INSTABILITY
Cross-field-current driven lower-hybrid instability and stochastic ion heating, 2:42216 (PPPL-1327)

U

UCLLL
See LAWRENCE LIVERMORE LABORATORY
UHF RADIATION (01-100 GHZ)
See RADIOWAVE RADIATION
UHF RADIATION (100-1000 MHZ)
See RADIOWAVE RADIATION
UHF RADIATION (LOWER RANGE)
See RADIOWAVE RADIATION
UHF RADIATION (UPPER RANGE)
See RADIOWAVE RADIATION
UKRAINIAN SSR/GEOLOGIC STRUCTURES
Contemporary structure of the Lower permian sedimentary strata of the Dnieper-Donets depression, 2:40927
UKRAINIAN SSR/SEISMIC SURVEYS
Contemporary structure of the Lower permian sedimentary strata of the Dnieper-Donets depression, 2:40927
ULTRASONIC WAVES/BIOLOGICAL EFFECTS
Quadrennial report of the division of biological effects, 1971-1974, 2:42078 (PB-258436)
ULTRASONICS
See ULTRASONIC WAVES
UNDERGROUND DISPOSAL/LICENSING
Review of state licenses for disposal of low-level radioactive waste by shallow land burial. Technical note, 2:41141 (PB-258259)
UNDERGROUND HEAT DISTRIBUTION SYSTEMS
See HEAT DISTRIBUTION SYSTEMS
UNDERGROUND MINING/ENVIRONMENTAL IMPACTS
Inactive and abandoned underground mines. Water pollution prevention and control, 2:42011 (PB-258263)
UNDERGROUND MINING/MINING EQUIPMENT
Transport of coal by shuttle trains at Dymitrow colliery, 2:40886
UNDERGROUND SPACE
See also MINES
UNDERGROUND SPACE/LEGAL ASPECTS
Strategies for legislative change (To encourage earth-covered construction), 2:41633 (NSF-RA-760006)
UNDERGROUND SPACE/MEETINGS
Alternatives in energy conservation: the use of earth covered buildings (Conference; about 525 references), 2:41609 (NSF-RA-760006)
UNDERGROUND SPACE/USES
Air quality and heat transfer (Earth-covered construction), 2:41593 (NSF-RA-760006)
Alternative to suburbia, 2:41591 (NSF-RA-760006)
Alternatives in energy conservation: the use of earth covered buildings (Conference; about 525 references), 2:41609 (NSF-RA-760006)
Build without destroying the Earth, 2:41592 (NSF-RA-760006)
Comparative life cycle costs (Earth-covered buildings), 2:41610 (NSF-RA-760006)
Comparison of energy consumption in earth-covered vs. non-earth-covered buildings, 2:41612 (NSF-RA-760006)
Earth-covered buildings and environmental impact, 2:41595 (NSF-RA-760006)
Psychology of earth-covered buildings, 2:41585 (NSF-RA-760006)
Soil and ground water considerations (Earth-covered construction), 2:41594 (NSF-RA-760006)
Strategies for legislative change (To encourage earth-covered construction), 2:41633 (NSF-RA-760006)
Study of earth-covered buildings by an electric utility company, 2:41613 (NSF-RA-760006)
Terraset Elementary School, Reston, Virginia (Underground, solar-heated), 2:41616 (NSF-RA-760006)
University of Minnesota book store, 2:41614 (NSF-RA-760006)
University of Houston student center, 2:41615 (NSF-RA-760006)
Urban geotecture: the invisible features of the civic profile, 2:41589 (NSF-RA-760006)
Use of earth covered buildings through history, 2:41588 (NSF-RA-760006)
Utilities for underground structures, 2:41590 (NSF-RA-760006)
UNDERWATER VEHICLES
See SUBMARINES
UNITED KINGDOM/COAL GASIFICATION
Prospects and problems for UCG in Britain, 2:40775 (MERC/SP-76/3)
UNITED KINGDOM/COAL INDUSTRY
Solving the coking coal problem, 2:40735
UNITED KINGDOM/METAL INDUSTRY
Solving the coking coal problem, 2:40735
UNITED KINGDOM/NUCLEAR POWER
UK experience of planning the nuclear contribution to the UK power programme, 2:41302 (IAEA-CN-36/53)
UNITED STATES OF AMERICA
See USA
URANIUM
See also URANIUM-ALPHA
URANIUM-BETA
URANIUM-GAMMA
URANIUM/ALPHA REACTIONS
Central collisions of relativistic heavy ions (250 to 2100-MeV/nucleon ^{20}Ne, 400-MeV/nucleon ^{4}He; light-particle energy spectra, differential cross sections), 2:42207
URANIUM/AUGER EFFECT
Auger/loss studies of uranium, uranium oxidation, UO_2, U_3O_8, and UF_4, 2:41781
URANIUM/DIFFUSION
Gradients of U, Pu and O at surfaces of (U, Pu)Osub(2+-x), 2:41853
URANIUM/ELECTRONIC STRUCTURE
Localized vs itinerant 5f electrons: a review of the experimental evidence, 2:41769
URANIUM/ENTHALPY
Enthalpy and heat capacity of liquid plutonium and uranium, 2:41806
URANIUM/FLUORINATION
Description of an engineering-scale facility for uranium fluorination studies, 2:41097 (JAERI-M-6487)
Development of F_2 two-step fluorination process for non-aqueous reprocessing, 2:41096 (JAERI-M-6393)
Fluorination of uranium compounds by gaseous bromine trifluoride and a bromine-fluorine mixture, 2:41077 (JAERI-1243)
Technical experiences in an engineering-scale facility for uranium fluorination studies, 2:41098 (JAERI-M-6488)
URANIUM/FORECASTING
Uranium--the world picture, 2:41073
URANIUM/LATTICE VIBRATIONS
Role of lattice vibrations in the determination of the physical properties of the actinides, 2:41773
URANIUM/LIQUID METALS
Model for liquid uranium and plutonium with implications on the adjacent solid phases, 2:41777
URANIUM/MATHEMATICAL MODELS
Model for liquid uranium and plutonium with implications on the adjacent solid phases, 2:41777
URANIUM/NEON 20 REACTIONS
Central collisions of relativistic heavy ions (250 to 2100-MeV/nucleon ^{20}Ne, 400-MeV/nucleon ^{4}He; light-particle energy spectra, differential cross sections), 2:42207
URANIUM/OXIDATION
Auger/loss studies of uranium, uranium oxidation, UO_2, U_3O_8, and UF_4, 2:41781
URANIUM/PRODUCTION
Uranium plant opens, 2:41079
URANIUM/PROSPECTING
Hydrogeochemical and stream-sediment survey of the National Uranium Resource Evaluation (NURE) program: western United States. Quarterly progress report, October-December 1976, 2:41074 (UCID-16911-76-4)
URANIUM/RECOVERY
Blyvooruitzicht embarks on a sixteen million Rand expansion programme, 2:41080
Recovery of uranium as a by-product of phosphorites from Brazilian northeast area, 2:41076 (IEA-416)
URANIUM/SEGREGATION
Segregation and vapour pressure studies on the uranium-plutonium-carbon system, 2:41839
URANIUM/SOLVENT EXTRACTION
Possible use of carboxylic acids for U/Pu separation in nuclear fuel reprocessing, 2:41090 (AERE-R-8509)
Simulation for control synthesis of a plutonium-uranium extraction process (Scrap recovery), 2:41094 (IS-M-25)
URANIUM/SPECIFIC HEAT
Enthalpy and heat capacity of liquid plutonium and uranium, 2:41806
URANIUM/VAPOR PRESSURE
Segregation and vapour pressure studies on the uranium-plutonium-carbon system, 2:41839
URANIUM 235/ISOTOPE SEPARATION
Isotopic separation by electrostatic filtration, 2:41082
URANIUM 235/SPECIFIC HEAT
Anomalous thermal property behaviour of uranium at low temperatures, 2:41793

URANIUM 238/SPECIFIC HEAT
Anomalous thermal property behaviour of uranium at low temperatures, 2:41793
URANIUM 238/THERMAL CONDUCTIVITY
Anomalous thermal property behaviour of uranium at low temperatures, 2:41793
URANIUM 238 TARGET/NEUTRON REACTIONS
Study of the $^{238}U(n,\gamma)^{239}U$ reaction, 2:42206 (INIS-mf-3352)
URANIUM ALLOYS
See also URANIUM BASE ALLOYS
URANIUM ALLOYS/CRYSTAL-PHASE TRANSFORMATIONS
Magnetic phase transitions in UO_2 and uranium compounds with crystal structures of Th_3P_4-type, 2:41780
Shear martensitic transformation in uranium alloys during quenching, plastic deformation and low temperature annealing, 2:41776
URANIUM ALLOYS/DE HAAS-VAN ALPHEN EFFECT
de Haas-van Alphen effect in URh_3 and UIr_3, 2:41762
URANIUM ALLOYS/ELECTRIC CONDUCTIVITY
Investigation of some magnetic and electric properties of compounds in the U-Ga system and of the U_3As_4 compound, 2:41803
URANIUM ALLOYS/ELECTRONIC SPECIFIC HEAT
Calorimetric study of the intermetallic compounds UAl_2 and $PuAl_2$, 2:41807
URANIUM ALLOYS/ELECTRONIC STRUCTURE
Electronic energy band structure of actinide metals and intermetallics, 2:41772
URANIUM ALLOYS/MAGNETIC SUSCEPTIBILITY
Investigation of some magnetic and electric properties of compounds in the U-Ga system and of the U_3As_4 compound, 2:41803
URANIUM ALLOYS/PHYSICAL RADIATION EFFECTS
Irradiation behaviour of UAlsub(x)-Al dispersion fuels for thermal high flux reactors, 2:41822
URANIUM ARSENIDES/CRYSTAL FIELD
Crystalline field and exchange interactions in the ternary uranium compounds of the U_2N_2M-type (M=P, As, S, Se), 2:41835
URANIUM ARSENIDES/CRYSTAL-PHASE TRANSFORMATIONS
Magnetic phase transitions in UO_2 and uranium compounds with crystal structures of Th_3P_4-type, 2:41780
URANIUM ARSENIDES/EXCHANGE INTERACTIONS
Crystalline field and exchange interactions in the ternary uranium compounds of the U_2N_2M-type (M=P, As, S, Se), 2:41835
URANIUM ARSENIDES/MAGNETIC SUSCEPTIBILITY
Investigation of some magnetic and electric properties of compounds in the U-Ga system and of the U_3As_4 compound, 2:41803
URANIUM BASE ALLOYS/CRYSTAL STRUCTURE
Relationship between structure and some properties of delta-Pu and γ-U alloys, 2:41821
URANIUM BASE ALLOYS/PHYSICAL RADIATION EFFECTS
Relationship between structure and some properties of delta-Pu and γ-U alloys, 2:41821
URANIUM BASE ALLOYS/THERMOELECTRIC PROPERTIES
Thermoelectric properties of solid solutions based on uranium and thorium, 2:41805
URANIUM BASE ALLOYS/YIELD STRENGTH
Some rules in the strengthening of uranium alloys, 2:41787
URANIUM CARBIDES/ELECTRIC CONDUCTIVITY
Electrical resistivity of uranium monophosphides, uranium mononitrides and uranium carbonitrides at low temperatures, 2:41843
URANIUM CARBIDES/EVAPORATION
Evaporation behaviour of the ternary uranium plutonium carbides, 2:41846
URANIUM CARBIDES/KNIGHT SHIFT
Nuclear magnetic resonance of carbon 13 and nitrogen 15 in uranium and thorium carbonitrides, 2:41824
URANIUM CARBIDES/LATTICE PARAMETERS
Lattice defects in actinide carbides and their relation to physical properties, 2:41844
URANIUM CARBIDES/MECHANICAL PROPERTIES
Physical and mechanical properties of some uranium-containing carbides, 2:41837
URANIUM CARBIDES/ORDER PARAMETERS
Study of atomic short-range order in nonstoichiometric actinide carbides by diffuse neutron scattering, 2:41832
URANIUM CARBIDES/PHASE DIAGRAMS
Some constitutional studies on uranium-carbon- and plutonium-carbon-rhenium and technetium systems, 2:41827
Some phase relationships and equilibria for the uranium-plutonium monocarbonitrides including the effects of oxygen on some equilibria, 2:41833
URANIUM CARBIDES/PHYSICAL PROPERTIES
Physical and mechanical properties of some uranium-containing carbides, 2:41837
URANIUM CARBIDES/PHYSICAL RADIATION EFFECTS
Enhancement of U_2C_3 deposition in electron bombarded $UC+UC_2$, 2:41856
Fission dose dependence of the lattice parameter change in fuel elements, 2:41858
HTGR fuels and core development program. Quarterly progress report for the period ending February 28, 1977, 2:41355 (GA-A-14298)
URANIUM CARBIDES/SEGREGATION
Segregation and vapour pressure studies on the uranium-plutonium-carbon system, 2:41839
URANIUM CARBIDES/SPIN-LATTICE RELAXATION
Nuclear magnetic resonance of carbon 13 and nitrogen 15 in uranium and thorium carbonitrides, 2:41824
URANIUM CARBIDES/THERMODYNAMIC PROPERTIES
Lattice defects in actinide carbides and their relation to physical properties, 2:41844
URANIUM CARBIDES/VAPOR PRESSURE
Evaporation behaviour of the ternary uranium plutonium carbides, 2:41846
Segregation and vapour pressure studies on the uranium-plutonium-carbon system, 2:41839
URANIUM DIOXIDE/AUGER EFFECT
Auger/loss studies of uranium, uranium oxidation, UO_2, U_3O_8, and UF_4, 2:41781
URANIUM DIOXIDE/CHEMICAL COMPOSITION
Determination of oxygen potentials of hyperstoichiometric U-Pu dioxides in the temperature range 1500-1850 K, 2:41826
URANIUM DIOXIDE/CREEP
Thermal creep of UO_2 and UO_2-PuO_2 in the stress range between 40 and 100 N/mm^2, 2:41836
URANIUM DIOXIDE/CRYSTAL-PHASE TRANSFORMATIONS
Magnetic phase transitions in UO_2 and uranium compounds with crystal structures of Th_3P_4-type, 2:41780
URANIUM DIOXIDE/DIFFUSION
Gradients of U, Pu and O at surfaces of (U, Pu)Osub(2+-x), 2:41853
URANIUM DIOXIDE/ELECTRIC CONDUCTIVITY
Measurements of the electrical resistance of UO_2-pins at high temperatures, 2:41851
URANIUM DIOXIDE/FABRICATION
Status of the development of mixed oxide fuels in PNC, 2:41489 (IAEA-CN-36/553)
Technological aspects of fuel manufacture for different power reactors, 2:41085 (IAEA-CN-36/352)
URANIUM DIOXIDE/FLUORINATION
Development of F_2 two-step fluorination process for non-aqueous reprocessing, 2:41096 (JAERI-M-6393)
Fluorination process studies of plutonium dioxide by fluid-bed, 2:41095 (JAERI-M-6392)
URANIUM DIOXIDE/LATTICE PARAMETERS
Low temperature lattice parameters of the actinide dioxides, 2:41830
URANIUM DIOXIDE/PHYSICAL RADIATION EFFECTS
Alpha radiation damage in the actinide dioxides, 2:41859
Fission dose dependence of the lattice parameter change in fuel elements, 2:41858
HTGR fuels and core development program. Quarterly progress report for the period ending February 28, 1977, 2:41355 (GA-A-14298)
Lattice defects and irradiation damage in ThO_2, UO_2 and $(U,Pu)O_2$, 2:41854
Performance evaluation of UO_2-Zr fuel in power ramp tests, 2:41487 (IAEA-CN-36/203)
Recovery processes in quenched and neutron irradiated uranium dioxide, 2:41855
URANIUM DIOXIDE/QUENCHING
Recovery processes in quenched and neutron irradiated uranium dioxide, 2:41855
URANIUM FLUORIDES
See also URANIUM HEXAFLUORIDE
URANIUM FLUORIDES/AUGER EFFECT
Auger/loss studies of uranium, uranium oxidation, UO_2, U_3O_8, and UF_4, 2:41781
URANIUM HEXAFLUORIDE/FLUORIDE VOLATILITY PROCESS
Adaptation of the continuous cold trap system of fluidized-bed to the fluoride volatility process, 2:41078 (JAERI-M-6405)
URANIUM HEXAFLUORIDE/MATERIALS HANDLING
Manual on safety handling of UF_6, 2:41144 (JAERI-M-6486)
URANIUM HYDRIDES/PHASE DIAGRAMS
Thermodynamics of the uranium (α,β and γ-phases)-hydrogen system, 2:41831
URANIUM IONS/CRYSTAL FIELD
Ab initio calculations of the crystal field splittings for Np^{3+} centers in CaF_2 (as well as for selected other complexes) by molecular orbital techniques, 2:41823

URANIUM IONS/MOLECULAR ORBITAL METHOD
Ab initio calculations of the crystal field splittings for Np^{3+} centers in CaF_2 (as well as for selected other complexes) by molecular orbital techniques, 2:41823
URANIUM ISOTOPES/ISOTOPE SEPARATION
Chemical and ion exchange unit for a cascade of uranium isotope separation, 2:41081
URANIUM MINES/RADIOACTIVE WASTE MANAGEMENT
Management of wastes containing radioactivity from mining and milling of uranium ores in Northern Australia, 2:41124 (IAEA-CN-36/418)
URANIUM NITRIDES/CRYSTAL FIELD
Crystalline field and exchange interactions in the ternary uranium compounds of the U_2N_2M-type (M=P, As, S, Se), 2:41835
URANIUM NITRIDES/ELECTRIC CONDUCTIVITY
Electrical resistivity of uranium monophosphides, uranium mononitrides and uranium carbonitrides at low temperatures, 2:41843
URANIUM NITRIDES/EXCHANGE INTERACTIONS
Crystalline field and exchange interactions in the ternary uranium compounds of the U_2N_2M-type (M=P, As, S, Se), 2:41835
URANIUM NITRIDES/KNIGHT SHIFT
Nuclear magnetic resonance of carbon 13 and nitrogen 15 in uranium and thorium carbonitrides, 2:41824
URANIUM NITRIDES/ORDER PARAMETERS
Study of atomic short-range order in nonstoichiometric actinide carbides by diffuse neutron scattering, 2:41832
URANIUM NITRIDES/PHASE DIAGRAMS
Some phase relationships and equilibria for the uranium-plutonium monocarbonitrides including the effects of oxygen on some equilibria, 2:41833
URANIUM NITRIDES/PHYSICAL RADIATION EFFECTS
Fission dose dependence of the lattice parameter change in fuel elements, 2:41858
URANIUM NITRIDES/PRODUCTION
Technological aspects of fuel manufacture for different power reactors, 2:41085 (IAEA-CN-36/352)
URANIUM NITRIDES/SPIN-LATTICE RELAXATION
Nuclear magnetic resonance of carbon 13 and nitrogen 15 in uranium and thorium carbonitrides, 2:41824
URANIUM ORES/MINING
Management of wastes containing radioactivity from mining and milling of uranium ores in Northern Australia, 2:41124 (IAEA-CN-36/418)
URANIUM ORES/ORE PROCESSING
Management and control of radioactive wastes from uranium-milling operations, 2:41125 (IAEA-CN-36/479)
Management of wastes containing radioactivity from mining and milling of uranium ores in Northern Australia, 2:41124 (IAEA-CN-36/418)
URANIUM OXIDES
See also URANIUM DIOXIDE
URANIUM OXIDES U3O8
URANIUM OXIDES/BINDING ENERGY
Bonding and valence in uranium compounds with oxygen: a study by X-ray photoelectron spectroscopy and electron paramagnetic resonance, 2:41850
URANIUM OXIDES/CHEMICAL BONDS
Electronic properties of actinide oxides, 2:41829
Optical properties of UO_2 and U_4O_9 single crystals and their relation to chemical bonding, 2:41842
URANIUM OXIDES/DIELECTRIC PROPERTIES
Optical properties of UO_2 and U_4O_9 single crystals and their relation to chemical bonding, 2:41842
URANIUM OXIDES/ELECTRIC CONDUCTIVITY
Electrical conductivity of (U,Pu) Osub(2+-x) in the pure state and with addition of molybdenum, 2:41847
URANIUM OXIDES/EVAPORATION
Advances in vapour pressure studies over liquid uranium plutonium oxides up to 5000K, 2:41845
URANIUM OXIDES/STATISTICAL MODELS
Unified model for defects in substoichiometric plutonium dioxide and uranium plutonium mixed oxides, 2:41828
URANIUM OXIDES/THERMODYNAMIC PROPERTIES
Thermodynamic properties of (U,Pu)Osub(2+-x) described by a cluster model, 2:41840
Thermodynamic studies at higher temperatures of the phase relationships of substoichiometric plutonium and uranium/plutonium oxides, 2:41848
URANIUM OXIDES/VAPOR PRESSURE
Advances in vapour pressure studies over liquid uranium plutonium oxides up to 5000K, 2:41845
URANIUM OXIDES U3O8/AUGER EFFECT
Auger/loss studies of uranium, uranium oxidation, UO_2, U_3O_8, and UF_4, 2:41781
URANIUM OXIDES U3O8/LATTICE PARAMETERS
Development of a routine method for the determination of mean crystallite dimensions in nuclear materials by X-ray diffraction line broadening. An application example using U_3O_8 microspheres, 2:41088 (IEA-405)
URANIUM OXIDES U3O8/SPECIFIC HEAT
Lambda-type heat capacity anomalies in U_3O_8, 2:41852
URANIUM PHOSPHIDES/CRYSTAL FIELD
Crystalline field and exchange interactions in the ternary uranium compounds of the U_2N_2M-type (M=P, As, S, Se), 2:41835
URANIUM PHOSPHIDES/CRYSTAL-PHASE TRANSFORMATIONS
Magnetic phase transitions in UO_2 and uranium compounds with crystal structures of Th_3P_4-type, 2:41780
URANIUM PHOSPHIDES/ELECTRIC CONDUCTIVITY
Electrical resistivity of uranium monophosphides, uranium mononitrides and uranium carbonitrides at low temperatures, 2:41843
URANIUM PHOSPHIDES/EXCHANGE INTERACTIONS
Crystalline field and exchange interactions in the ternary uranium compounds of the U_2N_2M-type (M=P, As, S, Se), 2:41835
URANIUM RESERVES
1974 assessment of Canada's uranium supply and demand, 2:41070 (INIS-mf-3382)
1975 assessment of Canada's uranium supply and demand, 2:41071 (INIS-mf-3388)
Uranium--the world picture, 2:41073
URANIUM RESERVES/FORECASTING
Uranium reserves, resources, and production, 2:41072 (PB-254896)
URANIUM SELENIDES/CRYSTAL FIELD
Crystalline field and exchange interactions in the ternary uranium compounds of the U_2N_2M-type (M=P, As, S, Se), 2:41835
URANIUM SELENIDES/CRYSTAL-PHASE TRANSFORMATIONS
Magnetic phase transitions in UO_2 and uranium compounds with crystal structures of Th_3P_4-type, 2:41780
URANIUM SELENIDES/EXCHANGE INTERACTIONS
Crystalline field and exchange interactions in the ternary uranium compounds of the U_2N_2M-type (M=P, As, S, Se), 2:41835
URANIUM SULFIDES/CRYSTAL FIELD
Crystalline field and exchange interactions in the ternary uranium compounds of the U_2N_2M-type (M=P, As, S, Se), 2:41835
URANIUM SULFIDES/ELECTRONIC STRUCTURE
Electronic structure of mixed uranium-thorium monochalcogenides, 2:41864
URANIUM SULFIDES/EXCHANGE INTERACTIONS
Crystalline field and exchange interactions in the ternary uranium compounds of the U_2N_2M-type (M=P, As, S, Se), 2:41835
URANIUM TELLURIDES/CRYSTAL STRUCTURE
Electronic structure of mixed uranium-thorium monochalcogenides, 2:41864
URANIUM TELLURIDES/CRYSTAL-PHASE TRANSFORMATIONS
Magnetic phase transitions in UO_2 and uranium compounds with crystal structures of Th_3P_4-type, 2:41780
URANIUM-ALPHA/PHASE DIAGRAMS
Thermodynamics of the uranium (α,β and γ-phases)-hydrogen system, 2:41831
URANIUM-BETA/PHASE DIAGRAMS
Thermodynamics of the uranium (α,β and γ-phases)-hydrogen system, 2:41831
URANIUM-GAMMA/CRYSTAL STRUCTURE
Relationship between structure and some properties of delta-Pu and γ-U alloys, 2:41821
URANIUM-GAMMA/PHASE DIAGRAMS
Thermodynamics of the uranium (α,β and γ-phases)-hydrogen system, 2:41831
URANIUM-GAMMA/PHYSICAL RADIATION EFFECTS
Relationship between structure and some properties of delta-Pu and γ-U alloys, 2:41821
URANUS PLANET/PLANETARY MAGNETOSPHERES
Polar aurora in the magnetosphere, 2:42193 (N-76-27751)
URANYL COMPOUNDS/PHOTOELECTRON SPECTROSCOPY
Electronic structure of uranyl compounds - an XPS study, 2:41849
URBAN AREAS/ARCHITECTURE
Urban geotecture: the invisible features of the civic profile, 2:41589 (NSF-RA-760006)
URBAN AREAS/LAND USE
Growth effects of major land use projects: Volume III. Summary. Final report, 2:41970 (PB-256204)
URBAN AREAS/PLANNING
Earth-covered buildings and environmental impact, 2:41595 (NSF-RA-760006)
URBAN AREAS/RAPID TRANSIT SYSTEMS
Station simulation studies for personalized rapid transit urban development, 2:41705
URBAN AREAS/TRANSPORTATION SYSTEMS
Assessing the relationship between urban form and travel requirements: a literature review and conceptual framework. Research report, 2:41687 (PB-254988)
Bus priority system simulator (Traffic signal system giving priority to buses), 2:41706

Development and operational validation of a transit bus simulation. Final research report, 2:41684 (PB-254891)
Effect of energy shortage and land use on automobile occupancy rate. Research report, 2:41685 (PB-254921)
Life cycle costing for current Rohr and AM general buses and General Motors RTS-II bus. Final report, Mar 1976-Jul 1976, 2:41715 (PB-255091)
Macroanalysis of the implications of major modal shifts in integrated regional transportation networks. Final summary report on phase 1, 2:41686 (PB-254923)
Risk analysis and transportation planning, 2:41704
Simulating an urban jitney system, 2:41708
System analysis, design, and operation of automated guideway transit systems, 2:41707
UCOST: a planning, scheduling, and costing system, 2:41703
Urban goods movement demonstration project design phases I and II. Executive summary, 2:41679 (PB-254854)
Use of simulation in the design of a dial-a-ride system, 2:41709

URBAN AREAS/UNDERGROUND
Alternative to suburbia, 2:41591 (NSF-RA-760006)

URINE/RADIOMETRIC ANALYSIS
Determination of heavy elements in humans, 2:42099 (BNWL-2088)
Estimation of lung and skeletal burdens of bone-seeking radionuclides in man from in vivo scintillation measurements of the thorax and the head, 2:42107 (BNWL-2088)
Methods for the assay of plutonium in vivo: what are the alternatives (^{238}Pu, ^{239}Pu, and ^{241}Am assay in vivo), 2:42108 (BNWL-2088)

UROGENITAL SYSTEM DISEASES/DIAGNOSIS
Scintiphotos in the diagnosis of renal allograft malfunction, 2:42061

US ERDA/FINANCIAL DATA
Comparison of compensation paid scientists and engineers in research and development. 1976 data, 2:42324 (ERDA-77-49)

US ERDA/RESEARCH PROGRAMS
Alternative liquid fuels and the ERDA program, 2:41639

USA
See also ALASKA
ARIZONA
CALIFORNIA
GEORGIA
HAWAII
IDAHO
ILLINOIS
INDIANA
LOUISIANA
MARYLAND
MASSACHUSETTS
MICHIGAN
MINNESOTA
MISSOURI
MONTANA
NEVADA
NEW MEXICO
NORTH CAROLINA
NORTH DAKOTA
OHIO
OREGON
PENNSYLVANIA
TENNESSEE
TEXAS
UTAH
VIRGINIA
WASHINGTON
WEST VIRGINIA
WISCONSIN
WYOMING

USA/ECONOMIC DEVELOPMENT
Long-run model for energy policy analysis, 2:41635

USA/ENERGY DEMAND
Methodological survey of energy modeling, 2:41630

USA/ENERGY POLICY
Implementing coal utilization provisions of Energy Supply and Environmental Coordination Act, 2:41640 (PB-255855)

USA/ENERGY SOURCE DEVELOPMENT
Methodological survey of energy modeling, 2:41630

USA/ENERGY SOURCES
Energy information report to Congress required by Public Law 93-319, amended by Public Law 94-163. First quarter 1976, 2:41600 (NTISUB/B-027-76/001)
Methodological survey of energy modeling, 2:41630
Monthly energy review, 2:41602 (NTISUB/B-127-76/007)

USA/ENERGY SUPPLIES
Long-run model for energy policy analysis, 2:41635

USA/GEOCHEMICAL SURVEYS
Hydrogeochemical and stream-sediment survey of the National Uranium Resource Evaluation (NURE) program: western United States. Quarterly progress report, October-December 1976, 2:41074 (UCID-16911-76-4)

USA/LAND RECLAMATION
Land Reclamation Program. Annual report, July 1975-July 1976, 2:40852 (ANL-76-XX-42)

USA/OIL FIELDS
Carbon dioxide sources and oilfields in a nine-state area of the southwest United States, 2:40930 (BERC/IC-77/1)

USA/SOLAR ENERGY
Solar energy: one way to citizen control, 2:41657

USA/SOLAR ENERGY CONVERSION
Solar energy in America's future: a preliminary assessment, 2:41656 (DSE/115-1)

USA/URANIUM RESERVES
Uranium reserves, resources, and production, 2:41072 (PB-254896)

USSR
See also UKRAINIAN SSR

USSR/COAL MINING
Coal cutting with a disk, 2:40885

USSR/GEOLOGIC STRATA
Prospects of discovering oil and gas deposits in the jurassic complexes of west siberia, 2:40922

USSR/GEOLOGIC STRUCTURES
New oil and gas exploration and prospecting directions in the Upper Pechora depression of the pre-Ural trough, 2:40925
Paleogeomorphological preconditions of discovery of petroleum and gas-bearing zones in the Jurassic and Triassic complexes of Northern Emba, 2:40923

USSR/GEOMORPHOLOGY
Paleogeomorphological preconditions of discovery of petroleum and gas-bearing zones in the Jurassic and Triassic complexes of Northern Emba, 2:40923

USSR/NATURAL GAS DEPOSITS
Phase state of hydrocarbons of the Caspian Depression, 2:40919

USSR/NATURAL GAS INDUSTRY
Natural gas in the tenth five year plan in the USSR, 2:41038

USSR/PETROLEUM DEPOSITS
Phase state of hydrocarbons of the Caspian Depression, 2:40919

UTAH/GEOLOGY
Summary of space imagery studies in Utah and Nevada, 2:42142 (E-76-10420)

UTAH/REMOTE SENSING
Summary of space imagery studies in Utah and Nevada, 2:42142 (E-76-10420)

UTERUS/PHYSIOLOGY
Indomethacin induces rat uterine contractions in vitro and alters reactivity to calcium and acetylcholine, 2:42068

V

VACUUM SYSTEMS/DESIGN
Dynamic constraints on inductive energy storage, 2:42298

VANADATES/CRYSTAL-PHASE TRANSFORMATIONS
Some actinides double orthovanadates and orthoarsenates: structural 'evolution' due to cationic and anionic substitutions, 2:41779

VANADIUM/ABSORPTION SPECTROSCOPY
Evaluation of carbon rod atomizer for routine analysis of vanadium in crude oil by atomic absorption spectroscopy, 2:41012

VANADIUM/METALLURGICAL EFFECTS
Metallurgical factors controlling weld metal toughness in the seam welding of line pipe, 2:41758 (PB-256057)

VANADIUM/RADIOACTIVATION
Low activation materials assessment for fusion reactors, 2:42315 (EPRI-ER-328-SR)

VANADIUM/SWELLING
Fusion power program. Quarterly progress report, October-December 1976, 2:42314 (ANL/FPP-76-6)

VANADIUM/VOLTAMETRY
Oxygen-bomb coulometric determination of vanadium in oils, 2:41015

VANADIUM/X-RAY EMISSION ANALYSIS
Investigation of size-dependent concentration of trace elements in aerosols emitted from the oil-fired heating plants, 2:40986 (N-76-27720)

VANADIUM ALLOYS/MECHANICAL PROPERTIES
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)

VANADIUM ALLOYS/THERMAL CONDUCTIVITY
Semi-annual report on materials research in support of superconducting machinery. Final report, 2:41784 (PB-261996)

VANADIUM OXIDES/SWELLING
Fusion power program. Quarterly progress report, October-December 1976, 2:42314 (ANL/FPP-76-6)

VEHICLES
See also AUTOMOBILES
BUSES
ELECTRIC-POWERED VEHICLES
HYBRID ELECTRIC-POWERED VEHICLES
TRUCKS
VEHICLES/DIESEL ENGINES
Effect of the stroke/bore ratio in a vehicle diesel engine with special regard to the combustion process in a hyperboloid combustion chamber, 2:41745
VELA PROJECT/DATA PROCESSING
Network capability estimation. Vela network evaluation and automatic processing research. Technical report, 2:41948 (AD-A-034897)
VELA PROJECT/RESEARCH PROGRAMS
Vela network evaluation and automatic processing research. Quarterly report No. 5, 10 Jul-10 Oct 1976, 2:41946 (AD-A-034769)
VENTURI TUBES/PERFORMANCE TESTING
Quarterly progress report on advanced two-phase instrumentation program for November-December 1976 (Water cooled reactor blowdown measurements), 2:41534 (ORNL/NUREG/TM-93)
VERMONT YANKEE REACTOR/REACTOR OPERATION
Annual operating report: January-December 1976, 2:41431 (DOCKET-50271-917)
VERY HIGH FREQUENCY RADIATION
See RADIOWAVE RADIATION
VESSELS (PRESSURE)
See PRESSURE VESSELS
VHF RADIATION
See RADIOWAVE RADIATION
VINYLBENZENE
See STYRENE
VIRGINIA/SCHOOL BUILDINGS
Terraset Elementary School, Reston, Virginia (Underground, solar-heated), 2:41616 (NSF-RA-760006)
VIRUSES
See also BACTERIOPHAGES
ONCOGENIC VIRUSES
VIRUSES/LETHAL IRRADIATION
Beneficial Uses Program progress report, period ending December 31, 1976 (Gamma inactivation of microorganisms in sewage sludge), 2:42074 (SAND-77-0426)
VISCOSITY/NOMOGRAMS
Nomograph for viscosity calculation in binary mixtures, 2:41025
VISIBLE RADIATION/BIOLOGICAL EFFECTS
Quadrennial report of the division of biological effects, 1971-1974, 2:42078 (PB-258436)
VOLTAIC CELLS
See ELECTRIC BATTERIES
VRAIN REACTOR/PRIMARY COOLANT CIRCUITS
Investigation into the causes and consequences of the malfunction of static shutdown seal S/N 3 in Fort St. Vrain circulator C2102 from the "D'" penetration, 2:41354 (GA-A-14049)
VRAIN REACTOR/REACTOR KINETICS
Evaluation of Fort St. Vrain nuclear analysis methods, 2:41353 (GA-A-14007)

W

W STELLARATORS/SUPERCONDUCTING MAGNETS
Full-size vacuum vessel and helical winding for the W VII Stellarator, 2:42297
WASHINGTON/ENERGY SUPPLIES
Crude supply alternatives for the northern tier states. Volume I. Executive summary, 2:41643 (PB-255992)
Crude supply alternatives for the northern tier states. Volume II. Technical report, 2:41644 (PB-255993)
WASHINGTON/WATER QUALITY
Environmental quality profile, 1976. Alaska, Oregon, Idaho, Washington. Final report, 2:41990 (PB-255101)
WASTE BURIAL
See UNDERGROUND DISPOSAL
WASTE DISPOSAL
See also RADIOACTIVE WASTE DISPOSAL
UNDERGROUND DISPOSAL
WASTE DISPOSAL/BIBLIOGRAPHIES
Coal mine waste (a bibliography with abstracts). Report for 1964-Nov 1976 (99 abstracts), 2:40870 (NTIS/PS-77/0040)
WASTE DISPOSAL/ENVIRONMENTAL EFFECTS
Assessment of long-term environmental impacts by computer modeling, 2:42016
WASTE DISPOSAL/ENVIRONMENTAL IMPACTS
Coal mine waste (a bibliography with abstracts). Report for 1964-Nov 1976 (99 abstracts), 2:40870 (NTIS/PS-77/0040)
WASTE HEAT/AERODYNAMICS
Eddy-flux measurements at the Dresden cooling pond (Fluxes of heat and momentum above Dresden reactors cooling pond), 2:42014 (ANL-75-60(Pt.4))
WASTE HEAT/DISTRICT HEATING
Reactor waste heat utilization and district heating reactors. Nuclear district heating in Sweden - Regional reject heat utilization schemes and small heat-only reactors, 2:41448 (IAEA-CN-36/275)
WASTE HEAT/FLUCTUATIONS
Eddy-flux measurements at the Dresden cooling pond (Fluxes of heat and momentum above Dresden reactors cooling pond), 2:42014 (ANL-75-60(Pt.4))
WASTE HEAT/HEAT DISTRIBUTION SYSTEMS
Waste heat utilisation by 'co-operative' group schemes, 2:41689
WASTE HEAT/WASTE MANAGEMENT
Selected aspects of waste heat management. Summary report, 2:41254 (PB-254401)
WASTE OILS/BIOLOGICAL EFFECTS
Environmental effects of Schuylkill oil spill II, June 1972, 2:40989 (PB-258412)
WASTE PROCESSING
See also MATERIALS RECOVERY
RADIOACTIVE WASTE PROCESSING
WASTE PROCESSING/HEALTH HAZARDS
Cautionary tale of a lead hazard in recycling of waste, 2:42134
WASTE PROCESSING PLANTS/OPERATION
Predictive criteria for construction/demolition solid waste management. Final report, 2:41690 (AD-A-034419)
WASTE SOLUTIONS
See LIQUID WASTES
WASTES
See also GASEOUS WASTES
LIQUID WASTES
MUNICIPAL WASTES
RADIOACTIVE WASTES
SOLID WASTES
WASTE HEAT
WASTES/USES
Technology for using sulfate waste in highway construction. Final report, 2:40850 (PB-254815)
WATER
See also DRINKING WATER
GROUND WATER
SEAWATER
SURFACE WATERS
WATER/CHEMICAL ANALYSIS
Development of high pressure liquid chromatographic techniques. Final report, 2:41870 (AD-A-026899)
WATER/QUANTITATIVE CHEMICAL ANALYSIS
Sensors for continuous monitoring of toxic ions, nutrients, and dissolved gases in water, 2:42015 (PB-254834)
WATER COOLED GRAPHITE MODERATED REACTORS
See LWGR TYPE REACTORS
WATER COOLED REACTORS
See also BWR TYPE REACTORS
LWGR TYPE REACTORS
ORR REACTOR
PWR TYPE REACTORS
SGHWR REACTOR
WATER COOLED REACTORS/BLOWDOWN
Inelastic response of nuclear piping subjected to rupture forces, 2:41541
Quarterly progress report on advanced two-phase instrumentation program for November-December 1976, 2:41534 (ORNL/NUREG/TM-93)
WATER COOLED REACTORS/COOLING PONDS
Eddy-flux measurements at the Dresden cooling pond (Fluxes of heat and momentum above Dresden reactors cooling pond), 2:42014 (ANL-75-60(Pt.4))
WATER COOLED REACTORS/FUEL CYCLE
Fuel cycle of the LWR system in the Federal Republic of Germany, 2:41111 (IAEA-CN-36/95)
WATER COOLED REACTORS/FUEL ELEMENTS
Nuclear fuel in water reactors: manufacturing technology operational experience and development activities in the Federal Republic of Germany, 2:41083 (IAEA-CN-36/103)
WATER COOLED REACTORS/HEAT EXCHANGERS
Operational experience with heat exchangers in nuclear power stations with light water reactors, 2:41480
WATER COOLED REACTORS/LOSS OF COOLANT
Two-dimensional analysis of conduction-controlled rewetting with precursory cooling, 2:41547
WATER COOLED REACTORS/REACTOR SAFETY
Summary of LWR safety research in the USA, 2:41530 (IAEA-CN-36/584)
WATER COOLED REACTORS/STEAM LINES
Inelastic response of nuclear piping subjected to rupture forces. 2:41541

WATER COOLED REACTORS/STEAM TURBINES
Water chemistry conditions of saturated steam turbines, 2:41479
WATER COOLED REACTORS/TRANSIENTS
Light-water reactor physics parameters for transient analysis. Final report 1 Jul 74-30 Jun 75, 2:41455 (PB-255169)
WATER POLLUTION/BIBLIOGRAPHIES
Water pollution analysis and detection. Volume 2. July 1974-January 1977 (a bibliography with abstracts). Report for Jul 1974-Jan 1977, 2:42007 (NTIS/PS-77/0027)
WATER POLLUTION/BIOLOGICAL EFFECTS
Laboratory technique for obtaining fathead minnow eggs for use in toxicity experiments, 2:42130
Physiological effects of sublethal levels of acid water on fish, 2:42122 (PB-253958)
WATER POLLUTION/MEASURING INSTRUMENTS
Shipboard oil-in-water monitor. Final report 24 May 74-30 Jun 76, 2:40983 (AD-A-028785)
WATER POLLUTION/MONITORING
Development of high pressure liquid chromatographic techniques. Final report, 2:41870 (AD-A-026899)
WATER POLLUTION CONTROL/FINANCING
Economic and financial impacts of federal air and water pollution controls on the electric utility industry. Executive summary. Final report, 2:41649 (PB-254307)
WATER QUALITY/COMPUTER CALCULATIONS
Assessment of long-term environmental impacts by computer modeling, 2:42016
WATER QUALITY/MONITORING
Sensors for continuous monitoring of toxic ions, nutrients, and dissolved gases in water, 2:42015 (PB-254834)
WATER RESOURCES/HYDROLOGY
Dickey-Lincoln School Lakes hydrothermal model study; hydraulic laboratory investigation. Final report, Jul 1975-Jun 1976, 2:41557 (AD-A-034538)
WAVE ENERGY CONVERTERS/DESIGN
Wave power nodding duck wave energy extractors, 2:41242
WAVES (SHOCK)
See SHOCK WAVES
WAXES
See also PARAFFIN
WAXES/ADDITIVES
Influence of polymeric additives on petroleum wax properties, 2:40969
WAXES/CHEMICAL COMPOSITION
Investigations of the bitumens of solid fuels under the electron microscope, 2:40807
Raw materials resources for the production of brown-coal wax, 2:40806
WAXES/CHEMICAL REACTIONS
Use of brown coals after the extraction of the montan wax for the production of sulfomethyl derivatives, 2:40808
WAXES/EXTRACTION
Use of brown coals after the extraction of the montan wax for the production of sulfomethyl derivatives, 2:40808
WAXES/MANUFACTURING
Some questions of the nonfuel processing of brown coals of the Dneprovskii basin, 2:40804
Tasks of scientific investigations in the field of waxes and accompanying products, 2:40803
WAXES/MELTING POINTS
Influence of polymeric additives on petroleum wax properties, 2:40969
WAXES/MOLECULAR STRUCTURE
Investigations of the bitumens of solid fuels under the electron microscope, 2:40807
WAXES/PHYSICAL PROPERTIES
Influence of polymeric additives on petroleum wax properties, 2:40969
Investigations of the bitumens of solid fuels under the electron microscope, 2:40807
Raw materials resources for the production of brown-coal wax, 2:40806
WAXES/PRODUCTION
Raw materials resources for the production of brown-coal wax, 2:40806
WAXES/STRUCTURAL CHEMICAL ANALYSIS
Investigations of the bitumens of solid fuels under the electron microscope, 2:40807
WAXES/USES
Some questions of the nonfuel processing of brown coals of the Dneprovskii basin, 2:40804
WEATHER/FORECASTING
SEASAT economic assessment. Volume 3: offshore oil and natural gas industry case study and generalization. Final report, Feb 1974-Aug 1975, 2:40931 (N-76-28616)
WEATHER/SOLAR ACTIVITY
Study of the relationship between solar activity and terrestrial weather, 2:42165 (N-76-28742)
Synoptic approach to sun-weather investigations, 2:42167 (N-76-29863)
WELDED JOINTS/DEFECTS
Automatic welding for an LNG storage tank of 9% nickel steel, 2:41049
WELDED JOINTS/MECHANICAL TESTS
Thermal strain effect of welding on the properties and stress state of welded joints in the pressure vessel of the A 1 reactor, 2:41374 (VR-688/76)
WELDED JOINTS/PHYSICAL RADIATION EFFECTS
Irradiation stability of welded joints (Neutron irradiation), 2:41820 (VR-691/76)
WELDED JOINTS/TESTING
Automatic welding for an LNG storage tank of 9% nickel steel, 2:41049
Determining fracture properties of reactor vessel forging materials, weldments, and bolting materials. Final report, 2:41783 (PB-257563)
WELDS
See WELDED JOINTS
WELL DRILLING
Drilling in the St Lawrence Lowlands of Quebec, 2:40920
WELL DRILLING/COST
Algorithm for cost effectiveness of directional versus vertical well drilling, 2:40785 (MERC/SP-76/3)
WELL DRILLING/DRILLING FLUIDS
Possibilities of biopolymer utilization for drilling fluids, 2:40934
WELL LOGGING/CALCULATION METHODS
Method of determination of abnormally high formation pressures from the data of geophysical investigations of boreholes, 2:40926
WELL STIMULATION/STEAM INJECTION
Thermal methods of hydrocarbon production--3. Hot fluid drive. principles and laboratory research, 2:40933
WELLS
See also GEOTHERMAL WELLS
NATURAL GAS WELLS
OIL WELLS
WELLS/WATER QUALITY
Hydrogeologic assessment of an underground coal gasification project site Grant District, Wettzel County, W. Va., 2:40855 (MERC/SP-76/3)
WENDELSTEIN-7 STELLARATOR/MAGNET COILS
Dynamic constraints on inductive energy storage, 2:42298
WENDELSTEIN-7 STELLARATOR/VACUUM SYSTEMS
Dynamic constraints on inductive energy storage, 2:42298
WEST VIRGINIA/COAL MINING
Contribution of ERTS-B to natural resource protection and recreational development in West Virginia. Progress report No. 3, 19 Mar-19 Jun 76, 2:40853 (E-76-10445)
WHISTLERS/DECAY INSTABILITY
Parametric decay of whistler waves, 2:42263
WHISTLERS/NONLINEAR PROBLEMS
Parametric decay of whistler waves, 2:42263
WIND
See also TORNADOES
WIND/BOUNDARY CONDITIONS
Sangamon Experiment: geostrophic wind profiles (Direct measurement), 2:41954 (ANL-75-60(Pt.4))
WIND POWER/AVAILABILITY
Wind power potential of Alaska. Part II. Wind duration curve fits and output power estimates for typical windmills, 2:41243 (RLO/2229/T12-76/1)
WIND POWER PLANTS/SITE SELECTION
Sites for wind power installations: wind tunnel simulation of the influence of two-dimensional ridges on wind speed and turbulence. Annual report, first year, 2:41245 (ERDA/NSF/00702-75/1)
WIND TURBINES/ALTERNATORS
Transient analysis of unbalanced short circuits of the ERDA-NASA 100-kW wind turbine alternator, 2:41244 (N-76-30650)
WINSTON COLLECTORS
See COMPOUND PARABOLIC CONCENTRATORS
WISCONSIN/ENERGY SUPPLIES
Crude supply alternatives for the northern tier states. Volume I. Executive summary, 2:41643 (PB-255992)
Crude supply alternatives for the northern tier states. Volume II. Technical report, 2:41644 (PB-255993)
WOOD/PYROLYSIS
Production of hydrocarbon-type synthetic fuel from wood, 2:41171 (AD-A-034359)
WOOD WASTES/FLUIDIZED-BED COMBUSTION
Fluidized vortex incineration of waste. Final report May 70-Aug 74, 2:41175 (PB-258071)
WOOD WASTES/GASIFICATION
Fluidized bed solids waste gasifier, 2:41172
WORKERS
See PERSONNEL

WWER TYPE REACTORS/DISTRICT HEATING
Experimental study of utilization of nuclear power heating plants for big towns and industrial agglomerations in Russia, 2:41451 (IAEA-CN-36/465)
WWER TYPE REACTORS/PRESSURIZERS
Quality assurance of production of steam generators and volume compensators for WWER-440 type nuclear power plants, 2:41336 (INIS-mf-3389)
WWER TYPE REACTORS/PRIMARY COOLANT CIRCUITS
In-service inspection of life and reliability of pipe system of WWER 1000 primary circuit, 2:41335 (INIS-mf-3389)
WWER TYPE REACTORS/STEAM GENERATORS
Quality assurance of production of steam generators and volume compensators for WWER-440 type nuclear power plants, 2:41336 (INIS-mf-3389)
WYOMING/COAL MINING
A comparative case study of the impact of coal development on the way of life of people in the coal areas of eastern Montana and northeastern Wyoming. Final report, 2:40856 (PB-254924)
WYOMING/RURAL POPULATIONS
A comparative case study of the impact of coal development on the way of life of people in the coal areas of eastern Montana and northeastern Wyoming. Final report, 2:40856 (PB-254924)

X

X RADIATION/BIOLOGICAL RADIATION EFFECTS
Fractionated x-irradiation damage to developing ovaries in the bonnet monkey (Macaca radiata), 2:42080 (UCD-472-123)
X RADIATION/ENERGY SPECTRA
FLAIR: a scaling and folding code for the generation of photon transport results in air. Final report, 2:42208 (AD-A-034754)
X-RAY DETECTION/GAS SCINTILLATION DETECTORS
Gas scintillation proportional counter for x-ray astronomy, 2:41928 (N-76-27550)
X-RAY DIFFRACTION
Development of a routine method for the determination of mean crystallite dimensions in nuclear materials by X-ray diffraction line broadening. An application example using U_3O_8 microspheres, 2:41088 (IEA-405)
X-RAY SOURCES
See also COSMIC X-RAY SOURCES
X-RAY SOURCES/**RADIOACTIVITY**
Biological effects of low levels of radiation exposure (Radiation hazards to man from radioactive consumer products), 2:42077 (UR-3490-1072)

Y

YANKEE CONNECTICUT REACTOR
See CONNECTICUT YANKEE REACTOR
YANKEE VERMONT REACTOR
See VERMONT YANKEE REACTOR
YTTERBIUM PERCHLORATES/OSMOSIS
Isopiestic determination of the activity coefficients of some aqueous rare earth electrolyte solutions at 25°C. II. The rare earth perchlorates, 2:41874
YTTRIUM ALLOYS/THERMOELECTRIC PROPERTIES
Thermoelectric properties of solid solutions based on uranium and thorium, 2:41805
YTTRIUM ALLOYS/VACUUM COATING
Coatings for directional eutectics. Final report (NiCrAlCy coating for NiTaC-13), 2:41814 (N-76-29370)

Z

ZEA MAYS
See MAIZE
ZINC/ABSORPTION SPECTROSCOPY
Determination of trace metals in crude oils by nonflame atomic absorption spectroscopy, 2:41014
ZINC/MINERAL CYCLING
Exchange of manganese, iron, copper, and zinc between dissolved and particulate forms in the Newport River estuary, North Carolina, 2:42003 (RLO-2227-T12-71)
ZINC/X-RAY EMISSION ANALYSIS
Investigation of size-dependent concentration of trace elements in aerosols emitted from the oil-fired heating plants, 2:40986 (N-76-27720)
ZINC COMPOUNDS/ACTIVATION ANALYSIS
Preferential adsorption in the lubrication process of zinc dialkyldithiophosphate, 2:41009
ZINC COMPOUNDS/CHROMATOGRAPHY
Preferential adsorption in the lubrication process of zinc dialkyldithiophosphate, 2:41009
ZINC-AIR BATTERIES/DESIGN
Process for producing electric current by the electrochemical oxidation of an active anodic metal, especially zinc (Anodic metal suspended in circulating electrolyte, metal repeatedly recovered by contact with more electronegative metal; patent), 2:41569
ZIRCALOY 2/PHYSICAL RADIATION EFFECTS
Performance evaluation of UO_2-Zr fuel in power ramp tests, 2:41487 (IAEA-CN-36/203)
ZIRCONIUM ALLOYS/CRYSTAL-PHASE TRANSFORMATIONS
Shear martensitic transformation in uranium alloys during quenching, plastic deformation and low temperature annealing, 2:41776
ZIRCONIUM ALLOYS/SELF-DIFFUSION
Melting-diffusion correlation in the plutonium-zirconium alloys, 2:41778
ZIRCONIUM ALLOYS/THERMOELECTRIC PROPERTIES
Thermoelectric properties of solid solutions based on uranium and thorium, 2:41805

REPORT NUMBER INDEX

The numbers assigned to all reports cited in the publication appear in the first column of the index. The citation numbers are included in the second column. Cross reference information and/or availability are included as appropriate. Abbreviations used in the availability column are elaborated at the end of the index.

Report No.	*Abstract No.*	*Availability*
AD-A-		
026576	2:41891	NTIS, $3.50
026597	2:41587	NTIS, $5.00
026638	2:41167	NTIS, $4.00
026666	2:41753	NTIS, $3.50
026822	2:41878	NTIS, PC A03/MF A01
026899	2:41870	NTIS, $4.00
026905	2:41926	NTIS, $5.50
027041	2:42175	NTIS, $4.00
027047	2:41932	NTIS, PC A03/MF A01
027848	2:40982	NTIS, PC A02/MF A01
028234	2:41892	NTIS, $3.50
028323	2:41658	NTIS, $9.00
028402	2:41893	NTIS, $4.00
028516	2:42187	NTIS, $3.50
028785	2:40983	NTIS, $4.50
028846	2:41755	NTIS, $4.50
028888	2:41680	NTIS, $4.50
028978	2:42148	NTIS, $5.00
029155	2:41232	NTIS, PC A03/MF A01
029389	2:41943	NTIS, PC A08/MF A01
029916	2:41894	NTIS, $5.50
030059	2:42188	NTIS, $4.50
030274	2:41756	NTIS, $4.00
030683	2:41871	NTIS, $3.50
030739	2:42176	NTIS, $4.00
030741	2:42177	NTIS, $4.00
030785	2:42075	NTIS, $4.00
030791	2:41795	NTIS, PC A03/MF A01
030874	2:42135	NTIS, PC A07/MF A01
030896	2:42136	NTIS, PC A08/MF A01
030924	2:42254	NTIS, $4.50
031022	2:42209	NTIS, $4.00
031114	2:42059	NTIS, PC A02/MF A01
031163	2:41196	NTIS, $6.00
031211	2:41197	NTIS, $9.75
034326	2:41895	NTIS, PC A04/MF A01
034359	2:41171	NTIS, PC A02/MF A01
034361	2:42210	NTIS, PC A02/MF A01
034381	2:42178	NTIS, PC A03/MF A01
034399	2:41944	NTIS, PC A02/MF A01
034405	2:42223	NTIS, PC A03/MF A01
034416	2:41174	NTIS, PC A04/MF A01
034419	2:41690	NTIS, PC A06/MF A01
034425	2:41933	NTIS, PC A06/MF A01
034450	2:42305	NTIS, PC A02/MF A01
034454	2:41663	NTIS, PC A03/MF A01
034490	2:42179	
034515	2:41872	NTIS, PC A03/MF A01
034537	2:41922	NTIS, PC A05/MF A01
034538	2:41557	NTIS, PC A05/MF A01
034552	2:41710	NTIS, PC A07/MF A01
034583	2:41896	NTIS, PC A02/MF A01
034611	2:41632	NTIS, PC A07/MF A01
034613	2:41924	NTIS, PC A05/MF A01
034661	2:41811	NTIS, PC A02/MF A01
034674	2:41897	NTIS, PC A07/MF A01
034675	2:41170	NTIS, PC A02/MF A01
034680	2:41898	NTIS, PC A03/MF A01
034723	2:41812	NTIS, PC A04/MF A01
034731	2:42189	NTIS, PC A03/MF A01
034754	2:42208	NTIS, PC A05/MF A01
034769	2:41946	NTIS, PC A02/MF A01
034783	2:42190	NTIS, PC A03/MF A01
034791	2:41934	NTIS, PC A14/MF A01
034883	2:41947	NTIS, PC A03/MF A01
034885	2:41818	NTIS, PC A03/MF A01
034897	2:41948	NTIS, PC A04/MF A01
034900	2:41899	NTIS, PC A06/MF A01
AD-B-		
006305	2:41234	NTIS, $5.00
AD-D-		
003269	2:40984	NTIS, PC A02/MF A01
003275	2:41574	NTIS, PC A02/MF A01
AED-Conf-		
76-506-002	2:42233	Dep. NTIS (US Sales Only), PC A02/MF A01
76-506-003	2:42301	Dep. NTIS (US Sales Only), PC A02/MF A01
76-506-007	2:42271	Dep. NTIS (US Sales Only), PC A02/MF A01
76-506-008	2:42211	Dep. NTIS (US Sales Only), PC A02/MF A01
76-506-023	2:42234	Dep. NTIS (US Sales Only), PC A02/MF A01
AEDC-TR-		
76-152	2:41922	*See* AD-A-034537
AERE-R-		
8509	2:41090	Dep. NTIS (US Sales Only), PC A03/MF A01
AFGL-AFSG-		
344	2:42177	*See* AD-A-030741
AFGL-ERP-		
555	2:42175	*See* AD-A-027041
561	2:42148	*See* AD-A-028978
564	2:42176	*See* AD-A-030739
AFGL-TR-		
76-0080	2:42175	*See* AD-A-027041
76-0115	2:42148	*See* AD-A-028978
76-0119	2:42176	*See* AD-A-030739
76-0124	2:42177	*See* AD-A-030741
AFWL-TR-		
76-234	2:41944	*See* AD-A-034399
AI-ERDA-		
13191	2:41378	Dep. NTIS, PC A02/MF A01
AIRESEARCH-		
74-10996(3)	2:41208	*See* N-76-30656
74-10996(4)	2:41206	*See* N-76-30653
74-10996(5)	2:41207	*See* N-76-30655
74-10996(7)	2:41209	*See* N-76-30659
74-10996(8)	2:41210	*See* N-76-30660
ANL-		
75-60(Pt.4)	2:41950	Dep. NTIS, PC A06/MF A01
76-75	2:41312	Dep. NTIS, PC A04/MF A01
76-98	2:41567	Dep. NTIS, PC A04/MF A01
76-XX-42	2:40852	Dep. NTIS, PC A03/MF A01
77-13	2:41961	Dep. NTIS, PC A05/MF A01
7411(Suppl.10)	2:42325	Dep. NTIS, $12.75

Report No.	Abstract No.	Availability
ANL/FPP-76-6	2:42314	Dep. NTIS, PC A05/MF A01
AP-42-Suppl-6	2:41989	*See* PB-254274
ARH-SA-279	2:41868	Dep. NTIS, PC A03/MF A01
ASE-3857	2:41929	*See* N-76-30527
ATR-76(7310)-1	2:41608	*See* N-76-31090
76(7405)-2	2:42163	*See* N-76-27149
76(7467)-1	2:41711	*See* PB-255929
BBN-3222	2:42136	*See* AD-A-030896
BERC/IC-77/1	2:40930	Dep. NTIS, $4.00
BERC/PPS-77/2	2:40998	Dep. NTIS, PC A02/MF A01
BM-IC-8711	2:41692	*See* PB-254222
8723	2:40880	*See* PB-262119
BM-RI-8146	2:41816	*See* PB-257 384
8195	2:40881	*See* PB-262189
BMFT-FB-T-75-22	2:41163	*See* N-76-24421
75-44	2:41884	*See* N-76-30534
BMVG-FBWT-75-6	2:41664	*See* N-76-24724
BNL-22237	2:41925	Dep. NTIS, PC A02/MF A01
22436	2:42302	Dep. NTIS, PC A02/MF A01
BNL-NUREG-50602(Pt.1)	2:41509	Dep. NTIS, PC A08/MF A01
50615	2:41465	Dep. NTIS, PC A03/MF A01
BNWL-1845-31	2:41155	Dep. NTIS, PC A03/MF A01
2088	2:42093	Dep. NTIS, $9.00
2139	2:42272	Dep. NTIS, PC A04/MF A01
2152	2:41313	Dep. NTIS, PC A05/MF A01
2153	2:41492	Dep. NTIS, PC A03/MF A01
BNWL-SA-5966	2:42076	Dep. NTIS, $3.50
BR-51432	2:41165	*See* N-76-30504
BRL-266-76	2:41940	*See* UCID-17379
Bull-6	2:42122	*See* PB-253958
Bull-A-185	2:41217	*See* PB-255928
C-781-b	2:41997	*See* PB-255302
781-c	2:41970	*See* PB-256204
CALT-767P6-X11	2:42062	Dep. NTIS, PC A02/MF A01
CEA-CONF-3615	2:41091	Dep. NTIS (US Sales Only), PC A02/MF A01
3638	2:41566	Dep. NTIS (US Sales Only), PC A02/MF A01
3657	2:41865	Dep. NTIS (US Sales Only), PC A02/MF A01
3663	2:41486	Dep. NTIS (US Sales Only), PC A03/MF A01
3683	2:41092	Dep. NTIS (US Sales Only), PC A02/MF A01
CEA-R-4798	2:41327	Dep. NTIS (US Sales Only), PC A07/MF A01
CERF-EE-3	2:41870	*See* AD-A-026899
CERL-TR-E-95	2:41174	*See* AD-A-034416
CMR-76-8	2:41862	*See* N-76-30026
CNES-NT-31	2:41565	*See* N-76-27695
34	2:41225	*See* N-76-27433
CONF-750384-	(12. annual OHOLO biological conference, Ma'alot, Israel, 16-19 Mar 1975) 2:42127	John Wiley and Sons, Inc. (1976).
CONF-750411-96	(European nuclear conference, Paris, France, 21-25 Apr 1975) 2:41094	*See* IS-M-25
CONF-750460-	(3. conference on the laser, New York, New York, USA, 22-25 Apr 1975) 2:41909	New York Academy of Sciences (1976).
CONF-750770-	(Conference on alternatives in energy conservation the use of earth covered buildings, Fort Worth, Texas, United States of America (USA), 9-12 Jul 1975) 2:41609	*See* NSF-RA-760006
CONF-760252-	(Symposium on low activation materials assessment for fusion reactors, San Francisco, California, United States of America (USA), 19-20 Feb 1976) 2:42315	*See* EPRI-ER-328-SR
CONF-760541-	(Meeting of the Society for Experimental Stress Analysis, Washington, District of Columbia, United States of America (USA), 9-14 May 1976) 2:41941	*See* UCRL-77305(Rev.1)
2 CONF-7605137-	(Annual meeting of the French Society of Heat Engineers: thermal aspects of actual energy problems, Grenoble, France, 24 May 1976) 2:41566	*See* CEA-CONF-3638
1 CONF-7605151-	(Technical meeting mining and mineralurgy session, Caen, France, 11 May 1976) 2:41091	*See* CEA-CONF-3615
1 CONF-760611-	(International conference on quantum electronics and exhibition, Amsterdam, Netherlands, 14-18 Jun 1976) 2:41902	*See* LA-UR-75-2260
9 CONF-760697-	(Workshop on measurement of heavy elements in vivo, Seattle, Washington, United States of America (USA), 24-25 Jun 1976) 2:42093	*See* BNWL-2088
CONF-760817-	(2. underground coal gasification symposium, Morgantown, West Virginia, United States of America (USA), 10-12 Aug 1976) 2:40745	*See* MERC/SP-76/3
CONF-760823-	(Meeting of the American Institute of Chemical Engineers, Atlantic City, New Jersey, United States of America (USA), 27 Aug-2 Sep 1976) 2:41092	*See* CEA-CONF-3683
10 CONF-760915-	(Modern trend in activation analysis, Munich, German, Federal Republic of (F.R. Germany), 13-17 Sep 1976) 2:41865	*See* CEA-CONF-3657
10 CONF-760972-	(Network Systems Corporation users symposium, Minneapolis, Minnesota, United States of America (USA), 16-17 Sep 1976) 2:42334	*See* UCRL-79161
2 CONF-761012-	(6. international conference on plasma physics and controlled nuclear fusion research, Berchtesgaden, German, Federal Republic of (F.R. Germany), 6-13 Oct 1976)	
45	2:42302	*See* BNL-22436
71	2:42211	*See* AED-Conf-76-506-008
72	2:42234	*See* AED-Conf-76-506-023
73	2:42271	*See* AED-Conf-76-506-007
74	2:42233	*See* AED-Conf-76-506-002
75	2:42301	*See* AED-Conf-76-506-003
CONF-761059-	(4. annual conference on the use of small accelerators, Denton, Texas, United States of America (USA), 25-27 Oct 1976)	
18 CONF-761062-	2:42076	*See* BNWL-SA-5966
	(47. shock and vibration symposium, Albuquerque, New Mexico, United States of America (USA), 19-21 Oct 1976)	
9 CONF-761155-	2:41938	*See* UCRL-78339(Rev.1)
	(4. workshop on laser interaction and related plasma phenomena, Troy, New York, United States of America (USA), 8-12 Nov 1976)	
3 CONF-761161-	2:42308	*See* UCRL-77943(Rev.2)
	(Seminar on in-situ use of gamma spectrometry for studying and monitoring the water-reactor spent fuels, Courbevoie, France, 16 Nov 1976)	
1 CONF-770101-	2:41486	*See* CEA-CONF-3663
	(7. symposium on sharing of computer programs and technology in nuclear medicine, Atlanta, Georgia, United States of America (USA), 16-17 Jan 1977)	
2	2:42084	Dep. NTIS, PC A02/MF A01

Report No.	Abstract No.	Availability
CONF-770116-		(Workshop on application of phase diagrams in metallurgy and ceramics, Gaithersburg, Maryland, United States of America (USA), 10-12 Jan 1977)
1	2:41863	Dep. NTIS, PC A02/MF A01
CONF-770201-		(5. international conference on luminescence dosimetry, Sao Paulo, Brazil, 14-17 Feb 1977)
2	2:41937	Dep. NTIS, PC A02/MF A01
CONF-770208-		(Symposium on public health aspects of radioactivity in consumer products, Atlanta, Georgia, United States of America (USA), 2-4 Feb 1977)
1	2:42077	*See* UR-3490-1072
CONF-770301-		(173. national meeting of the American Chemical Society, New Orleans, Louisiana, United States of America (USA), 20-25 Mar 1977)
7	2:41868	*See* ARH-SA-279
12	2:41466	Dep. NTIS, PC A02/MF A01
13	2:40798	Dep. NTIS, PC A02/MF A01
CONF-770303-		(Corrosion/77 NACE meeting, San Francisco, California, United States of America (USA), 14-18 Mar 1977)
11	2:41388	*See* HEDL-SA-1122
CONF-770401-		(5. international conference on reactor shielding, Knoxville, Tennessee, United States of America (USA), 18-22 Apr 1977)
3	2:41328	Dep. NTIS, PC A02/MF A01
4	2:41329	Dep. NTIS, PC A02/MF A01
6	2:41379	Dep. NTIS, PC A02/MF A01
8	2:41380	Dep. NTIS, PC A02/MF A01
9	2:41467	Dep. NTIS, PC A02/MF A01
13	2:41468	Dep. NTIS, PC A02/MF A01
CONF-770505-		(International conference on nuclear power and its fuel cycles, Salzburg, Austria, 2-13 May 1977)
	2:41516	*See* IAEA-CN-36/132
126	2:41889	*See* IAEA-CN-36/155
127	2:41106	*See* IAEA-CN-36/69
128	2:41107	*See* IAEA-CN-36/70
129	2:41108	*See* IAEA-CN-36/316
130	2:41307	*See* IAEA-CN-36/462
132	2:41303	*See* IAEA-CN-36/162
133	2:41391	*See* IAEA-CN-36/64
134	2:41399	*See* IAEA-CN-36/369
135	2:41445	*See* IAEA-CN-36/477
136	2:41488	*See* IAEA-CN-36/495
137	2:41087	*See* IAEA-CN-36/540
138	2:41083	*See* IAEA-CN-36/103
139	2:41487	*See* IAEA-CN-36/203
140	2:41086	*See* IAEA-CN-36/386
141	2:41520	*See* IAEA-CN-36/279
142	2:41489	*See* IAEA-CN-36/553
143	2:41357	*See* IAEA-CN-36/168
144	2:41085	*See* IAEA-CN-36/352
145	2:41111	*See* IAEA-CN-36/95
146	2:41444	*See* IAEA-CN-36/353
148	2:41448	*See* IAEA-CN-36/275
149	2:41306	*See* IAEA-CN-36/459
150	2:41517	*See* IAEA-CN-36/159
151	2:41526	*See* IAEA-CN-36/544
152	2:41515	*See* IAEA-CN-36/127
153	2:41319	*See* IAEA-CN-36/566
154	2:41315	*See* IAEA-CN-36/89
155	2:41530	*See* IAEA-CN-36/584
156	2:41316	*See* IAEA-CN-36/474
157	2:41525	*See* IAEA-CN-36/541
158	2:41318	*See* IAEA-CN-36/558
159	2:41309	*See* IAEA-CN-36/483
160	2:41469	*See* IAEA-CN-36/306
161	2:41331	*See* IAEA-CN-36/310
162	2:41524	*See* IAEA-CN-36/512
163	2:41523	*See* IAEA-CN-36/467
164	2:41334	*See* IAEA-CN-36/569
165	2:41497	*See* IAEA-CN-36/238
166	2:41332	*See* IAEA-CN-36/537
168	2:41360	*See* IAEA-CN-36/586
169	2:41358	*See* IAEA-CN-36/325
170	2:41356	*See* IAEA-CN-36/94
171	2:41528	*See* IAEA-CN-36/560
172	2:41359	*See* IAEA-CN-36/578
173	2:41084	*See* IAEA-CN-36/270
174	2:41450	*See* IAEA-CN-36/376
175	2:41507	*See* IAEA-CN-36/93
176	2:41368	*See* IAEA-CN-36/184
177	2:41367	*See* IAEA-CN-36/179
178	2:41522	*See* IAEA-CN-36/393
179	2:41370	*See* IAEA-CN-36/394
180	2:41518	*See* IAEA-CN-36/181
181	2:41366	*See* IAEA-CN-36/63
182	2:41369	*See* IAEA-CN-36/385
184	2:41371	*See* IAEA-CN-36/547
185	2:41519	*See* IAEA-CN-36/245
186	2:41396	*See* IAEA-CN-36/326
187	2:41404	*See* IAEA-CN-36/497
188	2:41394	*See* IAEA-CN-36/268
189	2:41390	*See* IAEA-CN-36/54
190	2:41398	*See* IAEA-CN-36/356
191	2:41529	*See* IAEA-CN-36/572
192	2:41527	*See* IAEA-CN-36/551
193	2:41397	*See* IAEA-CN-36/332
194	2:41393	*See* IAEA-CN-36/266
195	2:41320	*See* IAEA-CN-36/577
196	2:41403	*See* IAEA-CN-36/489
197	2:41521	*See* IAEA-CN-36/322
198	2:41400	*See* IAEA-CN-36/424
199	2:41513	*See* IAEA-CN-36/36
200	2:41512	*See* IAEA-CN-36/18
201	2:41401	*See* IAEA-CN-36/427
202	2:41392	*See* IAEA-CN-36/164
203	2:41402	*See* IAEA-CN-36/478
204	2:41395	*See* IAEA-CN-36/302
205	2:41317	*See* IAEA-CN-36/475
206	2:41333	*See* IAEA-CN-36/568
207	2:41127	*See* IAEA-CN-36/511
208	2:41132	*See* IAEA-CN-36/317
209	2:41125	*See* IAEA-CN-36/479
210	2:41114	*See* IAEA-CN-36/98
211	2:41119	*See* IAEA-CN-36/226
212	2:41116	*See* IAEA-CN-36/178
213	2:41133	*See* IAEA-CN-36/366
214	2:41112	*See* IAEA-CN-36/15
215	2:41117	*See* IAEA-CN-36/187
216	2:41128	*See* IAEA-CN-36/554
217	2:41131	*See* IAEA-CN-36/186
218	2:41115	*See* IAEA-CN-36/156
219	2:41134	*See* IAEA-CN-36/470
220	2:41126	*See* IAEA-CN-36/491
221	2:41123	*See* IAEA-CN-36/388
222	2:41140	*See* IAEA-CN-36/346
223	2:41120	*See* IAEA-CN-36/231
224	2:41124	*See* IAEA-CN-36/418
225	2:41122	*See* IAEA-CN-36/350
226	2:41138	*See* IAEA-CN-36/313
227	2:41113	*See* IAEA-CN-36/28
228	2:41137	*See* IAEA-CN-36/289
229	2:41104	*See* IAEA-CN-36/23
230	2:41118	*See* IAEA-CN-36/206
231	2:41121	*See* IAEA-CN-36/282
232	2:41136	*See* IAEA-CN-36/67
233	2:41139	*See* IAEA-CN-36/345
234	2:41105	*See* IAEA-CN-36/33
235	2:41628	*See* IAEA-CN-36/581
236	2:41447	*See* IAEA-CN-36/52
237	2:41438	*See* IAEA-CN-36/337
238	2:41493	*See* IAEA-CN-36/588
239	2:41308	*See* IAEA-CN-36/464
240	2:41451	*See* IAEA-CN-36/465
241	2:41301	*See* IAEA-CN-36/6
242	2:41449	*See* IAEA-CN-36/338
243	2:41302	*See* IAEA-CN-36/53
244	2:41304	*See* IAEA-CN-36/365
COO-		
2383-0035	2:42326	Dep. NTIS, PC A02/MF A01
2456-41	2:42273	Dep. NTIS, PC A02/MF A01
2510-12	2:41130	Dep. NTIS, PC A03/MF A01
2689-6	2:41135	Dep. NTIS, PC A04/MF A01
2756-1	2:40985	Dep. NTIS, PC A07/MF A01
2790-2	2:41900	Dep. NTIS, PC A02/MF A01
2975-3	2:41350	Dep. NTIS, PC A03/MF A01
4020-3	2:42212	Dep. NTIS, PC A07/MF A01
4055-1	2:41901	Dep. NTIS, PC A04/MF A01
COO/2839-		
1	2:41201	Dep. NTIS, PC A06/MF A01
CRBRP-ARD-		
0106(Vol.2)	2:41351	AT
0106(Vol.3)	2:41381	AT
CRN-HE-		
76-15	2:41931	Dep. NTIS (US Sales Only), PC A10/MF A01

Report No.	Abstract No.	Availability
CS-INIS-		
3	2:41330	Dep. NTIS (US Sales Only), PC A02/MF A01
26	2:41300	Dep. NTIS (US Sales Only), PC A03/MF A01
27	2:41314	Dep. NTIS (US Sales Only), PC A02/MF A01
29	2:41382	Dep. NTIS (US Sales Only), PC A02/MF A01
30	2:41453	Dep. NTIS (US Sales Only), PC A02/MF A01
DEU-		
76-38	2:41352	Dep. NTIS (US Sales Only), PC A02/MF A01
DHEW/PUBL/FDA-		
76/8058	2:42078	*See* PB-258436
DLR-IB-		
456-75/5	2:41158	*See* N-76-24726
456-75/6	2:41903	*See* N-76-24562
DME/NAE-		
1976(3)	2:41710	*See* AD-A-034552
DOCKET-50245-		
956	2:41429	
DOCKET-50254-		
1006	2:41430	
DOCKET-50265-		
975	2:41430	*See* DOCKET-50254-1006
DOCKET-50271-		
917	2:41431	
DOCKET-STN-50580-		
1	2:41432	
DOCKET-STN-50581-		
1	2:41432	*See* DOCKET-STN-50580-1
DP-		
20437-Vol-1	2:41716	*See* PB-256220
20437-Vol-3	2:41717	*See* PB-256221
DR-		
916	2:41232	*See* AD-A-029155
DRES-TN-		
365	2:41871	*See* AD-A-030683
DSD-		
35	2:41584	*See* PB-255949
DSE/115-		
1	2:41656	Dep. NTIS, PC A07/MF A01
E-		
76-10419	2:40869	NTIS, $4.50
76-10420	2:42142	NTIS, $4.00
76-10445	2:40853	NTIS, $3.50
8069	2:41782	*See* N-76-26287
8628	2:41964	*See* N-76-29738
8821	2:41244	*See* N-76-30650
EBO-P-		
673	2:41813	Dep. NTIS (US Sales Only), PC A02/MF A01
EE-TR-		
7605	2:40982	*See* AD-A-027848
EEI-		
76-85	2:41648	Edison Electric Inst., New York, NY
EGG-		
1183-2331	2:41927	Dep. NTIS, $5.00
EPA-		
430/9-75/018	2:40988	*See* PB-257950
430/9-75/019	2:40989	*See* PB-258412
440/9-76/019	2:41696	*See* PB-258068
450/2-76/013	2:41992	*See* PB-257892
450/2-76/016a	2:41993	*See* PB-257975
520/3-76/011	2:41362	*See* PB-258150
530/SW-130	2:41259	*See* PB-253326
910/9-76/026	2:41990	*See* PB-255101
R8-TS-5	2:41248	*See* PB-258264
EPA-SW-		
47d	2:41691	*See* PB-253330
118	2:41693	*See* PB-255139
161	2:41694	*See* PB-255141
500	2:41698	*See* PB-258266
EPA-TR-		
76-132	2:41069	*See* PB-254559-T/SL
76-142	2:41067	*See* PB-254581-T/SL
76-165	2:41986	*See* PB-254560-T/SL
EPRI-ER-		
328-SR	2:42315	Dep. NTIS, PC A06/MF A01
ERDA-		
76-94/2	2:40907	Dep. NTIS, PC A04/MF A01
77-18	2:42235	Dep. NTIS, PC A05/MF A01
77-47/5	2:41180	Dep. NTIS, PC A04/MF A01
77-49	2:42324	Dep. NTIS, PC A02/MF A01
77-54	2:41726	Dep. NTIS, PC A05/MF A01
ERDA/JPL/954373-		
76/5	2:41181	Dep. NTIS, $4.50
ERDA/JPL/954374-		
76/4	2:41182	Dep. NTIS, $4.00
ERDA/JPL/954458-		
76/3	2:41183	Dep. NTIS, $4.00
ERDA/JPL/954475-		
76/3	2:41184	Dep. NTIS, $4.50
ERDA/NSF/00702-		
75/1	2:41245	Dep. NTIS, $5.00
ERDE-TN-		
84	2:41165	*See* N-76-30504
ESA-CR(P)-		
799	2:41185	*See* N-76-27586
ESA-SR-		
25	2:42192	*See* N-76-27758
ESRO-ESTL-		
17	2:41185	*See* N-76-27586
EUR-CEA-FC-		
838	2:42224	Dep. NTIS (US Sales Only), PC A03/MF A01
848	2:42213	Dep. NTIS (US Sales Only), PC A03/MF A01
852	2:42316	Dep. NTIS (US Sales Only), PC A03/MF A01
855-TR	2:42214	Dep. NTIS (US Sales Only), PC A02/MF A01
862	2:42225	Dep. NTIS (US Sales Only), PC A03/MF A01
F-		
75-20	2:41883	*See* N-76-27444
F76-		
10	2:42166	*See* N-76-29361
FDA/BRH-		
76/123	2:42078	*See* PB-258436
FE-		
1760-26	2:41659	Dep. NTIS, $4.00
2203-12	2:41169	Dep. NTIS, $6.75
2307-13	2:40794	Dep. NTIS, $4.00
2321-8	2:40795	Dep. NTIS, $3.50
FEA/B-		
76/156	2:41600	*See* NTISUB/B-027-76/001
76/219	2:41581	*See* PB-254163
76/285	2:41601	*See* NTISUB/B-127-76/006
76/329	2:41602	*See* NTISUB/B-127-76/007
76/335	2:40978	*See* PB-255920
76/355	2:40914	*See* NTISUB/B-130-76/004
76/377	2:40911	*See* NTISUB/B-127-76/009
FEA/D-		
76/364	2:41626	*See* PB-256182
FEA/G-		
76/193	2:41640	*See* PB-255855
76/331	2:40996	*See* PB-255476
FEA/H-		
76/220	2:41634	*See* PB-255319
FEL-		
56	2:42075	*See* AD-A-030785
FES-		
76/1	2:41634	*See* PB-255319
FJSRL-TR-		
76-0012	2:42223	*See* AD-A-034405
FR-		
2677-101	2:40983	*See* AD-A-028785
G-		
7658	2:42173	*See* N-76-25115
GA-A-		
14007	2:41353	Dep. NTIS, PC A05/MF A01
14049	2:41354	Dep. NTIS, PC A05/MF A01
14079	2:41510	Dep. NTIS, PC A09/MF A01
14236	2:41383	Dep. NTIS, PC A03/MF A01
14240	2:41384	Dep. NTIS, PC A12/MF A01
14298	2:41355	Dep. NTIS, PC A12/MF A01
14304	2:41093	Dep. NTIS, PC A13/MF A01
GCA-TR-		
76-18-G	2:40979	*See* PB-262001
GE-		
75TMP-68	2:42010	*See* PB-256068
GEAP-		
10028-60	2:41385	AT
13771-21	2:41386	AT
14078-5	2:41387	AT
21304-3	2:41511	Dep. NTIS, PC A02/MF A01
GEP/PH-		
76D-12	2:41899	*See* AD-A-034900

Report No.	Abstract No.	Availability
GJBX-34(77)	2:41074	*See* UCID-16911-76-4
GS/PROD-832/1/76/C	2:41758	*See* PB-256057
GSA/FPA/MCL-TM-233	2:41945	*See* PB-257702
HASL-318	2:42085	Dep. NTIS, PC A12/MF A01
318(App.)	2:41987	Dep. NTIS, PC A18/MF A01
HEDL-SA-1122	2:41388	Dep. NTIS, PC A03/MF A01
HEDL-TC-812	2:41500	AT
HEDL-TI-76034-6	2:41501	AT
HEDL-TME-76-66	2:41389	AT
IA-1327	2:41627	Dep. NTIS (US Sales Only), PC A02/MF A01
IAEA-CN-35/15	2:42302	*See* BNL-22436
35/B8-1	2:42233	*See* AED-Conf-76-506-002
35/B13	2:42234	*See* AED-Conf-76-506-023
35/D1	2:42211	*See* AED-Conf-76-506-008
35/D-3	2:42271	*See* AED-Conf-76-506-007
35/G3-3	2:42301	*See* AED-Conf-76-506-003
36/6	2:41301	Dep. NTIS (US Sales Only), PC A03/MF A01
36/15	2:41112	Dep. NTIS (US Sales Only), PC A02/MF A01
36/18	2:41512	Dep. NTIS (US Sales Only), PC A02/MF A01
36/23	2:41104	Dep. NTIS (US Sales Only), PC A02/MF A01
36/28	2:41113	Dep. NTIS (US Sales Only), PC A02/MF A01
36/33	2:41105	Dep. NTIS (US Sales Only), PC A02/MF A01
36/36	2:41513	Dep. NTIS (US Sales Only), PC A02/MF A01
36/52	2:41447	Dep. NTIS (US Sales Only), PC A02/MF A01
36/53	2:41302	Dep. NTIS (US Sales Only), PC A02/MF A01
36/54	2:41390	Dep. NTIS (US Sales Only), PC A02/MF A01
36/63	2:41366	Dep. NTIS (US Sales Only), PC A02/MF A01
36/64	2:41391	Dep. NTIS (US Sales Only), PC A02/MF A01
36/67	2:41136	Dep. NTIS (US Sales Only), PC A02/MF A01
36/69	2:41106	Dep. NTIS (US Sales Only), PC A02/MF A01
36/70	2:41107	Dep. NTIS (US Sales Only), PC A02/MF A01
36/73	2:41514	Dep. NTIS (US Sales Only), PC A02/MF A01
36/89	2:41315	Dep. NTIS (US Sales Only), PC A02/MF A01
36/93	2:41507	Dep. NTIS (US Sales Only), PC A02/MF A01
36/94	2:41356	Dep. NTIS (US Sales Only), PC A02/MF A01
36/95	2:41111	Dep. NTIS (US Sales Only), PC A02/MF A01
36/98	2:41114	Dep. NTIS (US Sales Only), PC A02/MF A01
36/103	2:41083	Dep. NTIS (US Sales Only), PC A02/MF A01
36/127	2:41515	Dep. NTIS (US Sales Only), PC A02/MF A01
36/132	2:41516	Dep. NTIS (US Sales Only), PC A02/MF A01
36/155	2:41889	Dep. NTIS (US Sales Only), PC A02/MF A01
36/156	2:41115	Dep. NTIS (US Sales Only), PC A02/MF A01
36/159	2:41517	Dep. NTIS (US Sales Only), PC A02/MF A01
36/162	2:41303	Dep. NTIS (US Sales Only), PC A02/MF A01
36/164	2:41392	Dep. NTIS (US Sales Only), PC A02/MF A01
36/168	2:41357	Dep. NTIS (US Sales Only), PC A02/MF A01
36/178	2:41116	Dep. NTIS (US Sales Only), PC A02/MF A01
36/179	2:41367	Dep. NTIS (US Sales Only), PC A02/MF A01
36/181	2:41518	Dep. NTIS (US Sales Only), PC A02/MF A01
36/184	2:41368	Dep. NTIS (US Sales Only), PC A02/MF A01
36/186	2:41131	Dep. NTIS (US Sales Only), PC A02/MF A01
36/187	2:41117	Dep. NTIS (US Sales Only), PC A02/MF A01
36/203	2:41487	Dep. NTIS (US Sales Only), PC A02/MF A01
36/206	2:41118	Dep. NTIS (US Sales Only), PC A02/MF A01
36/226	2:41119	Dep. NTIS (US Sales Only), PC A02/MF A01
36/231	2:41120	Dep. NTIS (US Sales Only), PC A02/MF A01
36/238	2:41497	Dep. NTIS (US Sales Only), PC A02/MF A01
36/245	2:41519	Dep. NTIS (US Sales Only), PC A02/MF A01
36/266	2:41393	Dep. NTIS (US Sales Only), PC A02/MF A01
36/268	2:41394	Dep. NTIS (US Sales Only), PC A02/MF A01
36/270	2:41084	Dep. NTIS (US Sales Only), PC A02/MF A01
36/275	2:41448	Dep. NTIS (US Sales Only), PC A02/MF A01
36/279	2:41520	Dep. NTIS (US Sales Only), PC A02/MF A01
36/282	2:41121	Dep. NTIS (US Sales Only), PC A02/MF A01
36/289	2:41137	Dep. NTIS (US Sales Only), PC A02/MF A01
36/302	2:41395	Dep. NTIS (US Sales Only), PC A02/MF A01
36/306	2:41469	Dep. NTIS (US Sales Only), PC A02/MF A01
36/310	2:41331	Dep. NTIS (US Sales Only), PC A02/MF A01
36/313	2:41138	Dep. NTIS (US Sales Only), PC A02/MF A01
36/316	2:41108	U02/MF A01
36/317	2:41132	Dep. NTIS (US Sales Only), PC A02/MF A01
36/322	2:41521	Dep. NTIS (US Sales Only), PC A02/MF A01
36/325	2:41358	Dep. NTIS (US Sales Only), PC A02/MF A01
36/326	2:41396	Dep. NTIS (US Sales Only), PC A02/MF A01
36/332	2:41397	Dep. NTIS (US Sales Only), PC A02/MF A01
36/337	2:41438	Dep. NTIS (US Sales Only), PC A02/MF A01
36/338	2:41449	Dep. NTIS (US Sales Only), PC A02/MF A01
36/345	2:41139	Dep. NTIS (US Sales Only), PC A02/MF A01
36/346	2:41140	Dep. NTIS (US Sales Only), PC A02/MF A01
36/350	2:41122	Dep. NTIS (US Sales Only), PC A03/MF A01
36/352	2:41085	Dep. NTIS (US Sales Only), PC A02/MF A01
36/353	2:41444	Dep. NTIS (US Sales Only), PC A02/MF A01
36/356	2:41398	Dep. NTIS (US Sales Only), PC A02/MF A01
36/365	2:41304	Dep. NTIS (US Sales Only), PC A02/MF A01
36/366	2:41133	Dep. NTIS (US Sales Only), PC A02/MF A01
36/369	2:41399	Dep. NTIS (US Sales Only), PC A02/MF A01
36/376	2:41450	Dep. NTIS (US Sales Only), PC A02/MF A01
36/385	2:41369	Dep. NTIS (US Sales Only), PC A02/MF A01

Report No.	Abstract No.	Availability
36/386	2:41086	Dep. NTIS (US Sales Only), PC A02/MF A01
36/388	2:41123	Dep. NTIS (US Sales Only), PC A02/MF A01
36/393	2:41522	Dep. NTIS (US Sales Only), PC A02/MF A01
36/394	2:41370	Dep. NTIS (US Sales Only), PC A02/MF A01
36/418	2:41124	Dep. NTIS (US Sales Only), PC A02/MF A01
36/420	2:41305	Dep. NTIS (US Sales Only), PC A02/MF A01
36/424	2:41400	Dep. NTIS (US Sales Only), PC A02/MF A01
36/427	2:41401	Dep. NTIS (US Sales Only), PC A02/MF A01
36/459	2:41306	Dep. NTIS (US Sales Only), PC A02/MF A01
36/462	2:41307	Dep. NTIS (US Sales Only), PC A02/MF A01
36/464	2:41308	Dep. NTIS (US Sales Only), PC A02/MF A01
36/465	2:41451	Dep. NTIS (US Sales Only), PC A02/MF A01
36/467	2:41523	Dep. NTIS (US Sales Only), PC A02/MF A01
36/470	2:41134	Dep. NTIS (US Sales Only), PC A02/MF A01
36/474	2:41316	Dep. NTIS (US Sales Only), PC A02/MF A01
36/475	2:41317	Dep. NTIS (US Sales Only), PC A02/MF A01
36/477	2:41445	Dep. NTIS (US Sales Only), PC A02/MF A01
36/478	2:41402	Dep. NTIS (US Sales Only), PC A02/MF A01
36/479	2:41125	Dep. NTIS (US Sales Only), PC A02/MF A01
36/483	2:41309	Dep. NTIS (US Sales Only), PC A02/MF A01
36/489	2:41403	Dep. NTIS (US Sales Only), PC A02/MF A01
36/491	2:41126	Dep. NTIS (US Sales Only), PC A02/MF A01
36/495	2:41488	Dep. NTIS (US Sales Only), PC A02/MF A01
36/497	2:41404	Dep. NTIS (US Sales Only), PC A02/MF A01
36/511	2:41127	Dep. NTIS (US Sales Only), PC A02/MF A01
36/512	2:41524	Dep. NTIS (US Sales Only), PC A02/MF A01
36/537	2:41332	Dep. NTIS (US Sales Only), PC A02/MF A01
36/540	2:41087	Dep. NTIS (US Sales Only), PC A02/MF A01
36/541	2:41525	Dep. NTIS (US Sales Only), PC A02/MF A01
36/544	2:41526	Dep. NTIS (US Sales Only), PC A02/MF A01
36/547	2:41371	Dep. NTIS (US Sales Only), PC A02/MF A01
36/551	2:41527	Dep. NTIS (US Sales Only), PC A02/MF A01
36/553	2:41489	Dep. NTIS (US Sales Only), PC A02/MF A01
36/554	2:41128	Dep. NTIS (US Sales Only), PC A02/MF A01
36/558	2:41318	Dep. NTIS (US Sales Only), PC A02/MF A01
36/560	2:41528	Dep. NTIS (US Sales Only), PC A02/MF A01
36/566	2:41319	Dep. NTIS (US Sales Only), PC A02/MF A01
36/568	2:41333	Dep. NTIS (US Sales Only), PC A02/MF A01
36/569	2:41334	Dep. NTIS (US Sales Only), PC A02/MF A01
36/572	2:41529	Dep. NTIS (US Sales Only), PC A02/MF A01
36/577	2:41320	Dep. NTIS (US Sales Only), PC A02/MF A01
36/578	2:41359	Dep. NTIS (US Sales Only), PC A02/MF A01
36/581	2:41628	Dep. NTIS (US Sales Only), PC A02/MF A01
36/584	2:41530	Dep. NTIS (US Sales Only), PC A03/MF A01
36/586	2:41360	Dep. NTIS (US Sales Only), PC A02/MF A01
36/588	2:41493	Dep. NTIS (US Sales Only), PC A02/MF A01
ICP-		
1109	2:41109	Dep. NTIS, PC A02/MF A01
IEA-		
405	2:41088	Dep. NTIS (US Sales Only), PC A02/MF A01
416	2:41076	Dep. NTIS (US Sales Only), PC A02/MF A01
IGPP-UCR-		
75-2	2:41241	*See* PB-258098
76-6	2:41236	*See* PB-262643
IITRI-E-		
6230-Rev.	2:41934	*See* AD-A-034791
6261-Rev.	2:41934	*See* AD-A-034791
IKE-		
2-33	2:41531	Dep. NTIS (US Sales Only), PC A04/MF A01
IMMR-		
13-M1-76	2:40878	*See* PB-255944
INIS-mf-		
3382	2:41070	Dep. NTIS (US Sales Only), PC A02/MF A01
3388	2:41071	Dep. NTIS (US Sales Only), PC A02/MF A01
3404	2:42229	Dep. NTIS (US Sales Only), PC A06/MF A01
INTEL-		
8005-007	2:41170	*See* AD-A-034675
IPPJ-		
240	2:42215	*See* N-76-25021
241	2:42295	*See* N-76-25023
IPPJ-T-		
24	2:42294	*See* N-76-25020
IRI-		
131-76-01	2:41502	Dep. NTIS (US Sales Only), PC A05/MF A01
IRS-A-		
9	2:41434	*See* PB-254804-T/SL
IS-		
4104	2:42337	Dep. NTIS, PC A03/MF A01
IS-M-		
25	2:41094	Dep. NTIS, PC A02/MF A01
ITC-		
260675	2:41196	*See* AD-A-031163
260675	2:41197	*See* AD-A-031211
JAERI-		
1243	2:41077	Dep. NTIS (US Sales Only), PC A02/MF A01
JAERI-M-		
6359	2:42275	Dep. NTIS (US Sales Only), PC A08/MF A01
6392	2:41095	Dep. NTIS (US Sales Only), PC A03/MF A01
6393	2:41096	Dep. NTIS (US Sales Only), PC A03/MF A01
6405	2:41078	Dep. NTIS (US Sales Only), PC A02/MF A01
6432	2:42317	Dep. NTIS (US Sales Only), PC A05/MF A01
6451	2:42292	Dep. NTIS (US Sales Only), PC A04/MF A01
6453	2:42285	Dep. NTIS (US Sales Only), PC A03/MF A01
6467	2:42303	Dep. NTIS (US Sales Only), PC A03/MF A01
6470	2:42293	Dep. NTIS (US Sales Only), PC A02/MF A01
6475	2:42286	Dep. NTIS (US Sales Only), PC A02/MF A01
6484	2:42276	Dep. NTIS (US Sales Only), PC A03/MF A01
6486	2:41144	Dep. NTIS (US Sales Only), PC A02/MF A01
6487	2:41097	Dep. NTIS (US Sales Only), PC A03/MF A01
6488	2:41098	Dep. NTIS (US Sales Only), PC A05/MF A01

Report No.	Abstract No.	Availability
6495	2:42287	Dep. NTIS (US Sales Only), PC A02/MF A01
JEN-		
351	2:42306	Dep. NTIS (US Sales Only), PC A04/MF A01
JPL-		
5040-29	2:41200	*See* N-76-28647
JPL-TM-		
33-781	2:41227	*See* N-76-28649
33-788	2:41935	*See* N-76-28223
33-789	2:41576	*See* N-76-28648
K/CSD-		
3	2:41440	Dep. NTIS, PC A05/MF A01
K/TL-		
639	2:41886	Dep. NTIS, PC A02/MF A01
644	2:41887	Dep. NTIS, PC A05/MF A01
KA-TR-		
128-Pt-2	2:41943	*See* AD-A-029389
Ktech-TR-		
75-19	2:41926	*See* AD-A-026905
L-		
10451	2:41204	*See* N-76-27671
10768	2:41963	*See* N-76-29382
10875	2:40986	*See* N-76-27720
LA-		
6482-MS	2:42327	Dep. NTIS, PC A05/MF A01
6583	2:41147	Dep. NTIS, PC A02/MF A01
6584	2:41148	Dep. NTIS, PC A02/MF A01
6638-M	2:42013	Dep. NTIS, PC A03/MF A01
6727-MS	2:42226	Dep. NTIS, PC A02/MF A01
LA-UR-		
75-2053	2:41149	Dep. NTIS, PC A02/MF A01
75-2260	2:41902	Dep. NTIS, PC A02/MF A01
LASL-		
77-3	2:42277	Dep. NTIS, PC A02/MF A01
LBL-		
6122	2:42338	Dep. NTIS, PC A08/MF A01
LG-		
76ER0076-V-1	2:41681	*See* N-76-24144
76ER0076-V-2	2:41682	*See* N-76-24145
LMEC-		
77-1	2:41405	AT
LRP-		
99/76	2:42245	*See* N-76-31015
MDC-J-		
7245	2:41738	*See* N-76-29188
MDC-M-		
0019-Vol-1	2:40876	*See* PB-254863
0019-Vol-2	2:40877	*See* PB-254864
MERC/SP-		
76/3	2:40745	Dep. NTIS, PC A25/MF A01
MIT-CE-R-		
75-34	2:41537	*See* PB-259188
MIT-EL-		
75-022	2:41455	*See* PB-255169
MML-TR-		
76-16c	2:41198	*See* PB-261910
MRL-		
646	2:41892	*See* AD-A-028234
MS-MSFC-		
1975	2:41936	*See* N-76-30279
MSNW-		
76-1053-1	2:41908	*See* UCRL-13713
N-		
76-24144	2:41681	NTIS, $4.50
76-24145	2:41682	NTIS, $12.00
76-24364	2:41860	NTIS, $4.00
76-24374	2:41160	NTIS, PC A02/MF A01
76-24421	2:41163	NTIS, PC A05/MF A01
76-24562	2:41903	NTIS, $3.50
76-24681	2:41962	NTIS, $3.50
76-24702	2:41203	NTIS, $6.75
76-24703	2:41571	NTIS, $4.00
76-24723	2:41159	NTIS, $9.25
76-24724	2:41664	NTIS, $5.50
76-24726	2:41158	NTIS, $4.00
76-24798	2:42180	NTIS, $4.50
76-24799	2:41988	NTIS, $4.50
76-25019	2:41660	NTIS, $3.50
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76-25023	2:42295	NTIS, $3.50
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76-25116	2:42162	NTIS, $4.00
76-26287	2:41782	NTIS, $4.00
76-27134	2:42152	NTIS, $4.50
76-27135	2:42157	NTIS, PC A03/MF A01
76-27149	2:42163	NTIS, PC A04/MF A01
76-27164	2:41735	NTIS, PC A09/MF A01
76-27304	2:42164	NTIS, $6.75
76-27359	2:41861	NTIS, PC A09/MF A01
76-27401	2:41757	NTIS
76-27433	2:41225	NTIS, PC A03/MF A01
76-27444	2:41883	NTIS, $5.50
76-27538	2:41904	NTIS, $6.75
76-27550	2:41928	NTIS, PC A02/MF A01
76-27586	2:41185	NTIS, $3.50
76-27643	2:40928	NTIS, $3.50
76-27667	2:41162	NTIS, $4.00
76-27671	2:41204	NTIS, $4.50
76-27673	2:41572	NTIS, PC A05/MF A01
76-27695	2:41565	NTIS, $3.50
76-27697	2:41575	NTIS, PC A03/MF A01
76-27720	2:40986	NTIS, $4.00
76-27750	2:42145	NTIS, $4.00
76-27751	2:42193	NTIS, $5.00
76-27752	2:42191	NTIS, $4.00
76-27753	2:42181	NTIS, $4.00
76-27758	2:42192	NTIS, $4.50
76-27996	2:42196	NTIS, PC A02/MF A01
76-28015	2:42230	NTIS, $4.00
76-28120	2:42158	NTIS, PC A03/MF A01
76-28122	2:42172	NTIS, $4.50
76-28123	2:42159	NTIS, $4.00
76-28125	2:42153	NTIS, $6.75
76-28148	2:42149	NTIS, $4.00
76-28203	2:41605	NTIS, $7.50
76-28204	2:41606	NTIS, $4.00
76-28223	2:41935	NTIS, $4.00
76-28224	2:41736	NTIS, $4.00
76-28340	2:41665	NTIS, $4.00
76-28369	2:41785	NTIS, $3.50
76-28404	2:41226	NTIS, $4.50
76-28429	2:41750	NTIS, $5.00
76-28511	2:41668	NTIS, $5.00
76-28616	2:40931	NTIS, $6.00
76-28619	2:40995	NTIS, $5.00
76-28642	2:41568	NTIS, PC A04/MF A01
76-28644	2:41193	NTIS, $3.50
76-28645	2:41186	NTIS, $4.50
76-28647	2:41200	NTIS, $5.00
76-28648	2:41576	NTIS, PC A03/MF A01
76-28649	2:41227	NTIS, $4.00
76-28651	2:41187	NTIS, $5.50
76-28652	2:41205	NTIS, $9.25
76-28653	2:41192	NTIS, $3.50
76-28682	2:42006	NTIS, PC A03/MF A01
76-28715	2:42182	NTIS, $4.00
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76-28723	2:42184	NTIS, $8.00
76-28738	2:41233	NTIS, $4.50
76-28742	2:42165	NTIS, $4.00
76-29018	2:42195	NTIS, $4.00
76-29064	2:41737	NTIS, PC A04/MF A01
76-29084	2:42154	NTIS, $5.00
76-29099	2:42155	NTIS, PC A06/MF A01
76-29148	2:42151	NTIS, $3.50
76-29149	2:42161	NTIS, $4.00
76-29188	2:41738	NTIS, $6.75
76-29233	2:41742	NTIS, $6.00
76-29361	2:42166	NTIS, $4.50
76-29370	2:41814	NTIS, PC A05/MF A01
76-29382	2:41963	NTIS, PC A06/MF A01
76-29705	2:41194	NTIS, $4.00
76-29738	2:41964	NTIS, $4.00
76-29782	2:42185	NTIS, $4.00
76-29863	2:42167	NTIS, $3.50
76-30026	2:41862	NTIS, $11.00
76-30045	2:42203	NTIS, $3.50
76-30046	2:41454	NTIS, $4.00
76-30126	2:42156	NTIS, $4.00
76-30218	2:41743	NTIS, $6.00
76-30257	2:42168	NTIS, PC A05/MF A01
76-30279	2:41936	NTIS, $3.50
76-30320	2:42194	NTIS, $3.50
76-30497	2:41164	NTIS, PC A09/MF A01
76-30504	2:41165	NTIS, PC A03/MF A01
76-30527	2:41929	NTIS, $4.00
76-30534	2:41884	NTIS, $5.00
76-30612	2:41253	NTIS, PC A02/MF A01
76-30650	2:41244	NTIS, $4.00
76-30653	2:41206	NTIS, $3.50

Report No.	Abstract No.	Availability
76-30655	2:41207	NTIS, $4.50
76-30656	2:41208	NTIS, $4.00
76-30657	2:41188	NTIS, $3.50
76-30659	2:41209	NTIS, $4.50
76-30660	2:41210	NTIS, $6.00
76-31015	2:42245	NTIS, $3.50
76-31018	2:42236	NTIS, $3.50
76-31079	2:41607	NTIS, $7.50
76-31090	2:41608	NTIS, $5.50
76-31109	2:42160	NTIS, $3.50
76-31115	2:42174	NTIS, PC A03/MF A01
76-31119	2:42150	NTIS, $4.00
76-31126	2:42169	NTIS, $4.00
NADC-		
76359-30	2:41811	*See* AD-A-034661
NASA-CR-		
2636	2:41735	*See* N-76-27164
2712	2:42195	*See* N-76-29018
2719	2:41454	*See* N-76-30046
134967	2:41568	*See* N-76-28642
134970	2:41750	*See* N-76-28429
135031	2:41162	*See* N-76-27667
135048	2:41572	*See* N-76-27673
135050	2:41814	*See* N-76-29370
135053	2:41743	*See* N-76-30218
135065	2:41742	*See* N-76-29233
137863	2:41738	*See* N-76-29188
137878	2:41606	*See* N-76-28204
137891	2:41607	*See* N-76-31079
137911	2:41737	*See* N-76-29064
137940	2:41608	*See* N-76-31090
138877	2:41605	*See* N-76-28203
144314	2:41203	*See* N-76-24702
144329	2:42163	*See* N-76-27149
144753	2:41571	*See* N-76-24703
144766	2:42166	*See* N-76-29361
144783	2:41904	*See* N-76-27538
144793	2:42194	*See* N-76-30320
144798	2:42168	*See* N-76-30257
144804	2:41929	*See* N-76-30527
144949	2:41682	*See* N-76-24145
144975	2:41681	*See* N-76-24144
145008	2:41186	*See* N-76-28645
147053	2:42180	*See* N-76-24798
147705	2:41860	*See* N-76-24364
147834	2:41665	*See* N-76-28340
147961	2:41660	*See* N-76-25019
148137	2:41962	*See* N-76-24681
148213	2:42152	*See* N-76-27134
148313	2:42230	*See* N-76-28015
148317	2:41861	*See* N-76-27359
148456	2:42181	*See* N-76-27753
148485	2:41576	*See* N-76-28648
148487	2:41935	*See* N-76-28223
148488	2:41227	*See* N-76-28649
148493	2:41200	*See* N-76-28647
148496	2:40931	*See* N-76-28616
148499	2:40995	*See* N-76-28619
148504	2:42184	*See* N-76-28723
148505	2:41187	*See* N-76-28651
148507	2:42182	*See* N-76-28715
148514	2:41668	*See* N-76-28511
148528	2:41205	*See* N-76-28652
148533	2:41233	*See* N-76-28738
148541	2:42165	*See* N-76-28742
148563	2:42156	*See* N-76-30126
148568	2:42167	*See* N-76-29863
148579	2:41862	*See* N-76-30026
148597	2:42185	*See* N-76-29782
148779	2:42150	*See* N-76-31119
149921	2:41883	*See* N-76-27444
149927	2:41757	*See* N-76-27401
149928	2:41226	*See* N-76-28404
149941	2:42183	*See* N-76-28719
149972	2:41208	*See* N-76-30656
149973	2:41207	*See* N-76-30655
149974	2:41209	*See* N-76-30659
149975	2:41210	*See* N-76-30660
149976	2:41206	*See* N-76-30653
149984	2:41936	*See* N-76-30279
NASA-TM-X-		
3294	2:41204	*See* N-76-27671
3401	2:40986	*See* N-76-27720
3403	2:41963	*See* N-76-29382
71131	2:42157	*See* N-76-27135
71139	2:42158	*See* N-76-28120
71148	2:42154	*See* N-76-29084
71150	2:42149	*See* N-76-28148
71151	2:42153	*See* N-76-28125
71152	2:42191	*See* N-76-27752
71158	2:42164	*See* N-76-27304
71167	2:42155	*See* N-76-29099
71168	2:41188	*See* N-76-30657
71171	2:42174	*See* N-76-31115
71172	2:42169	*See* N-76-31126
71174	2:42160	*See* N-76-31109
72830	2:41160	*See* N-76-24374
73318	2:42159	*See* N-76-28123
73459	2:41244	*See* N-76-30650
73922	2:41736	*See* N-76-28224
73930	2:42006	*See* N-76-28682
73932	2:41164	*See* N-76-30497
NASA-TN-D-		
8241	2:42173	*See* N-76-25115
8253	2:41964	*See* N-76-29738
8254	2:41782	*See* N-76-26287
NASA-TT-F-		
15462	2:40928	*See* N-76-27643
15488	2:42151	*See* N-76-29148
16733	2:42161	*See* N-76-29149
16744	2:41192	*See* N-76-28653
16745	2:41785	*See* N-76-28369
17056	2:42162	*See* N-76-25116
17074	2:42172	*See* N-76-28122
17104	2:42145	*See* N-76-27750
17106	2:42193	*See* N-76-27751
17137	2:41194	*See* N-76-29705
17138	2:41193	*See* N-76-28644
17150	2:42203	*See* N-76-30045
NBS-TN-		
680	2:41906	*See* PB-254066
NBSIR-		
76-837	2:41885	*See* PB-261709
76-848	2:41784	*See* PB-261996
76-1056	2:41211	*See* PB-254179
76-1076	2:41030	*See* PB-254180
76-1170	2:41812	*See* AD-A-034723
NOAA-TM-ERL-SEL-		
41	2:42186	*See* PB-256 102
44	2:41930	*See* PB-257833
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3426	2:42305	*See* AD-A-034450
NSF-RA-		
760006	2:41609	GPO, $3.25
NSF/RANN/SE/AER-		
7519576/PR/75/3	2:41190	*See* PB-256254
NSF/RANN/SE/GI-		
43090/FR/75/2	2:41189	*See* PB-255903
NTIS/PS-		
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NTISUB/B-		
027-76/001	2:41600	NTIS, $10.00
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127-76/007	2:41602	NTIS, $4.00
127-76/009	2:40911	NTIS, $4.00
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NUREG-		
0025-10	2:41433	*See* NTISUB/B-124-76/010
0040-02	2:41435	*See* PB-255418
0060	2:42138	*See* PB-255197

Report No.	Abstract No.	Availability
0069	2:41110	*See* PB-254786
0123	2:41436	*See* PB-258385
OAP-		
453	2:42152	*See* N-76-27134
OAQPS-		
1.2-044	2:41992	*See* PB-257892
OER/ER-		
6	2:40975	*See* PB-254943
7	2:40976	*See* PB-254944
8	2:41700	*See* PB-254945
ORAU/IEA(M)-		
76-15	2:41604	Dep. NTIS, PC A03/MF A01
77-6	2:41654	Dep. NTIS, PC A02/MF A01
ORNL-		
5206(Vol.1)	2:42231	Dep. NTIS, PC A17/MF A01
5252	2:40729	Dep. NTIS, PC A10/MF A01
5278	2:42278	Dep. NTIS, PC A03/MF A01
ORNL/CSD/TM-		
19	2:41495	Dep. NTIS, PC A05/MF A01
25	2:41145	Dep. NTIS, PC A03/MF A01
ORNL/EIS-		
107	2:42117	Dep. NTIS, PC A03/MF A01
ORNL/MIT-		
232	2:41503	Dep. NTIS, PC A06/MF A01
242	2:42296	Dep. NTIS, PC A04/MF A01
ORNL/NUREG/NSIC-		
131	2:41532	Dep. NTIS, PC A22/MF A01
ORNL/NUREG/TM-		
71	2:41494	Dep. NTIS, PC A09/MF A01
79	2:41496	Dep. NTIS, PC A06/MF A01
90	2:41533	Dep. NTIS, PC A03/MF A01
93	2:41534	Dep. NTIS, PC A03/MF A01
97	2:41321	Dep. NTIS, PC A02/MF A01
ORNL/Sub/4164-		
2	2:41472	Dep. NTIS, PC A03/MF A01
ORNL/Sub/81734-		
76/1	2:41604	*See* ORAU/IEA(M)-76-15
ORNL/TM-		
5411	2:40788	Dep. NTIS, PC A08/MF A01
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5566	2:41099	AT
5681	2:41406	AT
5819	2:40731	Dep. NTIS, $4.50
5858	2:40732	Dep. NTIS, PC A03/MF A01
ORO-		
3557-15	2:42318	Dep. NTIS, PC A03/MF A01
4946-2	2:40871	Dep. NTIS, PC A05/MF A01
5046-1	2:42328	Dep. NTIS, $3.50
ORP/LV-		
76-3	2:41141	*See* PB-258259
76-4	2:41996	*See* PB-258257
OTA-E-		
32	2:41598	*See* PB-258191
OUEL-		
1138/75	2:41253	*See* N-76-30612
P-		
203/75	2:41300	*See* CS-INIS-26
674	2:41382	*See* CS-INIS-29
675	2:41453	*See* CS-INIS-30
5324	2:41330	*See* CS-INIS-3
5577	2:41753	*See* AD-A-026666
22122	2:41314	*See* CS-INIS-27
PAT-		
036.3-7606	2:41603	*See* PB-254188
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PB-		
255 293	2:42009	NTIS, $7.50
256 102	2:42186	NTIS, $3.50
257 384	2:41816	NTIS, $4.00
258 329	2:41033	NTIS, $6.75
253326	2:41259	NTIS, $4.00
253330	2:41691	NTIS, $4.00
253669	2:41905	NTIS, $4.50
253713	2:41683	NTIS, $6.00
253958	2:42122	NTIS, $4.50
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254163	2:41581	NTIS, $5.00
254179	2:41211	NTIS, $4.00
254180	2:41030	NTIS, $4.00
254188	2:41603	NTIS, $7.50
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254304	2:41617	NTIS, $4.00
254305	2:41618	NTIS, $4.00
254307	2:41649	NTIS, $4.00
254308	2:41652	NTIS, $12.75
254315	2:41582	NTIS, $10.50
254399	2:41202	NTIS, $6.00
254400	2:40796	NTIS, $5.50
254401	2:41254	NTIS, $4.50
254413	2:41558	NTIS, $6.00
254415	2:41535	NTIS, $5.00
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254502	2:41215	NTIS, $3.50
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254589	2:41620	NTIS, $4.00
254590	2:41621	NTIS, $4.50
254591	2:41622	NTIS, $4.00
254628	2:41623	NTIS, $3.50
254629	2:41034	NTIS, $3.50
254639	2:41624	NTIS, $4.00
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254923	2:41686	NTIS, $4.00
254924	2:40856	NTIS, $9.75
254943	2:40975	NTIS, $3.50

Report No.	Abstract No.	Availability
254944	2:40976	NTIS, $5.00
254945	2:41700	NTIS, $5.00
254988	2:41687	NTIS, $4.00
254990	2:41240	NTIS, PC A03/MF A01
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255141	2:41694	NTIS, $5.50
255142	2:41597	NTIS, $9.25
255169	2:41455	NTIS, $4.00
255197	2:42138	NTIS, $9.25
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255277	2:41965	NTIS, $5.50
255288	2:41966	NTIS, $4.00
255298	2:40857	NTIS, $4.50
255302	2:41997	NTIS, $5.50
255313	2:41967	NTIS, $4.00
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255405	2:41456	NTIS, $5.00
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255543	2:40790	NTIS, $4.00
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255646	2:41199	NTIS, $4.50
255652	2:41673	NTIS, $9.25
255655	2:41674	NTIS, $7.50
255659	2:41247	NTIS, $9.75
255730	2:41968	NTIS, $4.50
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255944	2:40878	NTIS, $5.00
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255967	2:41274	NTIS, $11.00
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255993	2:41644	NTIS, $11.75
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256182	2:41626	NTIS, $4.00
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256254	2:41190	NTIS, $4.00
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257551	2:40900	NTIS, $6.00
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257567	2:41536	NTIS, $8.00
257702	2:41945	NTIS, PC A07/MF A01
257706	2:41971	NTIS, $8.00
257833	2:41930	NTIS, PC A03/MF A01
257891	2:41972	NTIS, $4.50
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257955	2:41695	NTIS, $5.00
257975	2:41993	NTIS, $7.50
258041-SET/SL	2:40858	NTIS, $20.50
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258044	2:40861	NTIS, $9.00
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258098	2:41241	NTIS, PC A07/MF A01
258100	2:41235	NTIS, PC A04/MF A01
258102	2:42139	NTIS, PC A06/MF A01
258137	2:41973	NTIS, $6.00
258138	2:41974	NTIS, $8.00
258150	2:41362	NTIS, $5.50
258191	2:41598	NTIS, $5.50
258232	2:41427	NTIS, $4.50
258257	2:41996	NTIS, $4.50
258259	2:41141	NTIS, $4.00
258260	2:41697	NTIS, $6.00
258263	2:42011	NTIS, $9.75
258264	2:41248	NTIS, $4.00
258266	2:41698	NTIS, $7.50
258271	2:42012	NTIS, $7.50
258279	2:41998	NTIS, $12.50
258304	2:40879	NTIS, $5.00
258330	2:41035	NTIS, $6.00
258344	2:41740	NTIS, $6.00
258385	2:41436	NTIS, $9.75
258412	2:40989	NTIS, $7.75
258436	2:42078	NTIS, $6.75
258471	2:41999	NTIS, PC A16/MF A01
258493	2:41191	NTIS, $4.50
258636	2:41641	NTIS, $3.50
258773	2:41699	NTIS, $4.50
259097	2:40990	NTIS, $10.50
259098	2:40991	NTIS, $9.00
259188	2:41537	NTIS, PC A08/MF A01
261709	2:41885	NTIS, PC A07/MF A01
261850	2:41228	NTIS, PC A04/MF A01
261910	2:41198	NTIS, PC A03/MF A01
261917	2:41975	NTIS, PC A04/MF A01
261918	2:41279	NTIS, PC A04/MF A01
261922	2:41976	NTIS, PC A10/MF A01
261996	2:41784	NTISA14
262001	2:40979	NTIS, PC A14/MF A01
262002	2:41977	NTIS, PC A07/MF A01
262092	2:41978	NTIS, PC A03/MF A01
262093	2:41979	NTIS, PC A17/MF A01
262094	2:41980	NTIS, PC A17/MF A01
262095	2:41981	NTIS, PC A25/MF A01
262096	2:41982	NTIS, PC A18/MF A01
262119	2:40880	NTIS, PC A05/MF A01
262160	2:42060	NTIS, PC A05/MF A01
262189	2:40881	NTIS, PC A02/MF A01
262348	2:41688	NTIS, PC A04/MF A01
262643	2:41236	NTIS, PC A03/MF A01
263007	2:42170	NTIS, PC A03/MF A01
263008	2:42171	NTIS, PC A06/MF A01
2556097	2:41276	NTIS, $12.75
2557029	2:40802	NTIS, $5.50
PGS-TR-PH-		
76-39	2:42230	*See* N-76-28015
Phoenix-		
015	2:41216	*See* PB-255049
016	2:41214	*See* PB-254495
017	2:41213	*See* PB-254494
018	2:41215	*See* PB-254502
019	2:41212	*See* PB-254493
PIFR-		
835	2:41924	*See* AD-A-034613
PM-		
76/4	2:42196	*See* N-76-27996
PNC-J-		
259-76-01	2:41819	Dep. NTIS (US Sales Only), PC A05/MF A01
PNC-N-		
941-75-113	2:41796	Dep. NTIS (US Sales Only), PC A03/MF A01
PPPL-		
1327	2:42216	Dep. NTIS, PC A02/MF A01
1329	2:42217	Dep. NTIS, PC A02/MF A01
1330	2:42218	Dep. NTIS, PC A03/MF A01
1337	2:42246	Dep. NTIS, PC A02/MF A01
PSI-TR-		
58	2:41897	*See* AD-A-034674
PSU-IRL-IR-		
55	2:42180	*See* N-76-24798
PSU-IRL-SCI-		
443	2:42181	*See* N-76-27753
444	2:42184	*See* N-76-28723
445	2:42185	*See* N-76-29782
PWA-		
5370	2:41750	*See* N-76-28429
5434	2:41742	*See* N-76-29233
PWA-FR-		
7108	2:41898	*See* AD-A-034680
R-		
76AEG432	2:41743	*See* N-76-30218

Report No.	Abstract No.	Availability
RAH-		
070	2:41644	*See* PB-255993
070A	2:41643	*See* PB-255992
RDT-E-		
6-33T	2:41437	RSO
REPT-		
1.2-DN-B-0104-1	2:41860	*See* N-76-24364
1.3-DN-C0504-036	2:41665	*See* N-76-28340
75-125-3B-V-3	2:40931	*See* N-76-28616
75-125-6B-V-6	2:40995	*See* N-76-28619
76-TR-10	2:41737	*See* N-76-29064
755	2:41988	*See* N-76-24799
RFP-		
2639	2:41888	Dep. NTIS, PC A02/MF A01
Rijnhuizen-		
76-99	2:42247	Dep. NTIS (US Sales Only), PC A02/MF A01
76-100	2:42227	Dep. NTIS (US Sales Only), PC A02/MF A01
RL-		
76-147/B	2:42307	Dep. NTIS (US Sales Only), PC A02/MF A01
RLO-		
2221-T2-31	2:42043	Dep. NTIS, PC A02/MF A01
2225-T25-18	2:42146	Dep. NTIS, PC A04/MF A01
2225-T36-1	2:41994	Dep. NTIS, PC A02/MF A01
2227-T12-71	2:42003	Dep. NTIS, PC A11/MF A01
2229-TC-3	2:42141	Dep. NTIS, PC A02/MF A01
RLO/2229/T12-		
76/1	2:41243	Dep. NTIS, $5.00
RM-		
613	2:41757	*See* N-76-27401
S-		
452	2:41735	*See* N-76-27164
SAI-		
76-680-LJ	2:42182	*See* N-76-28715
SAND-		
76-0358	2:41224	Dep. NTIS, PC A06/MF A01
76-8262	2:41879	Dep. NTIS, PC A03/MF A01
76-9314	2:41907	Dep. NTIS, PC A09/MF A01
77-0204	2:42319	Dep. NTIS, PC A03/MF A01
77-0426	2:42074	Dep. NTIS, PC A03/MF A01
77-0612	2:42329	Dep. NTIS, PC A02/MF A01
77-8006	2:41880	Dep. NTIS, PC A03/MF A01
SC-		
5015.2FR	2:42194	*See* N-76-30320
SGD-		
387-Pt-1	2:42171	*See* PB-263008
387-Pt-2	2:42170	*See* PB-263007
SGP-TR-		
10	2:42139	*See* PB-258102
SIGLUT-P-		
719	2:41322	Dep. NTIS (US Sales Only), PC A02/MF A01
SLAC-		
196	2:42330	Dep. NTIS, PC A05/MF A01
SRD-		
76-076	2:41814	*See* N-76-29370
SRO-		
890-2	2:42147	Dep. NTIS, PC A06/MF A01
SSC-TN-		
2625-12	2:41587	*See* AD-A-026597
SU-		
326P18X10	2:42331	Dep. NTIS, PC A03/MF A01
326-P.39-12	2:42333	*See* SU-SEL-76-025
326-P.39-16	2:42332	Dep. NTIS, PC A02/MF A01
SU-IPR-		
663	2:42167	*See* N-76-29863
671	2:42165	*See* N-76-28742
SU-SEL-		
76-009	2:42183	*See* N-76-28719
76-025	2:42333	Dep. NTIS, PC A03/MF A01
Systan-D-		
147	2:41686	*See* PB-254923
147	2:41701	*See* PB-256136
147-App	2:41702	*See* PB-256137
TAMU-SG-		
75-212	2:40991	*See* PB-259098
TE-		
5429-97-76	2:41247	*See* PB-255659
TFD-		
76-471	2:41756	*See* AD-A-030274
TI-ALEX-		
(01)QR-76-05	2:41946	*See* AD-A-034769
(01)-TR—76-04	2:41948	*See* AD-A-034897
(01)-TR-76-10	2:41947	*See* AD-A-034883
TR-		
1	2:41456	*See* PB-255405
TRB/SR-		
166	2:41683	*See* PB-253713
TRINEC-P-		
926	2:41452	Dep. NTIS (US Sales Only), PC A02/MF A01
TRITA-EPP-		
76-05	2:42236	*See* N-76-31018
UAG-R-		
240	2:41243	*See* RLO/2229/T12-76/1
UAH-RR-		
185	2:41893	*See* AD-A-028402
UCD-		
472-123	2:42118	Dep. NTIS, PC A08/MF A01
UCID-		
16911-76-4	2:41074	Dep. NTIS, PC A02/MF A01
17378	2:42339	Dep. NTIS, PC A04/MF A01
17379	2:41940	Dep. NTIS, PC A04/MF A01
17404	2:42279	Dep. NTIS, PC A02/MF A01
17431	2:42320	Dep. NTIS, PC A02/MF A01
UCLA-ENG-		
7672	2:42254	*See* AD-A-030924
UCRL-		
13713	2:41908	Dep. NTIS, PC A02/MF A01
50045-76-4	2:41538	Dep. NTIS, PC A03/MF A01
52223	2:41881	Dep. NTIS, PC A03/MF A01
52238	2:42140	Dep. NTIS, PC A02/MF A01
77305(Rev.1)	2:41941	Dep. NTIS, PC A02/MF A01
77943(Rev.2)	2:42308	Dep. NTIS, PC A03/MF A01
78339(Rev.1)	2:41938	Dep. NTIS, PC A02/MF A01
79161	2:42334	Dep. NTIS, PC A02/MF A01
UILU-ENG-		
76-2028	2:41472	*See* ORNL/Sub/4164-2
76-2545	2:41905	*See* PB-253669
UIUCDCS-R-		
76-839	2:42326	*See* COO-2383-0035
UJV-		
3778-R	2:41458	Dep. NTIS (US Sales Only), PC A03/MF A01
UMICH-		
013662-4-T	2:41688	*See* PB-262348
UMTA-URT-		
3-75-6	2:41687	*See* PB-254988
UNC-WRRI-		
76-113	2:42015	*See* PB-254834
UNI-		
187(Rev.1)	2:41506	Dep. NTIS, PC A02/MF A01
UR-		
3490-1072	2:42077	Dep. NTIS, PC A03/MF A01
UTRC-		
R76-912036-16	2:41605	*See* N-76-28203
R76-912036-17	2:41606	*See* N-76-28204
VPI-E-		
76-10	2:41861	*See* N-76-27359
VR-		
688/76	2:41374	Dep. NTIS (US Sales Only), PC A02/MF A01
691/76	2:41820	Dep. NTIS (US Sales Only), PC A02/MF A01
WA/DOE/BR-		
75/01	2:40987	*See* PB-254291
WARD-		
2171-64	2:41504	AT
WARD-CR-		
3045-15	2:41407	Dep. NTIS, PC A03/MF A01
WARD-OX-		
3045-28	2:41408	AT
WARD-RB-		
3045-14	2:41409	AT
WES-TR-H-		
76-22	2:41557	*See* AD-A-034538
WRI-WVU-		
76-01	2:42122	*See* PB-253958
X-		
582-76-153	2:42164	*See* N-76-27304
661-76-113	2:42157	*See* N-76-27135
661-76-119	2:42154	*See* N-76-29084
661-76-142	2:42158	*See* N-76-28120
661-76-182	2:42160	*See* N-76-31109
670-76-173	2:42155	*See* N-76-29099
682-76-128	2:42149	*See* N-76-28148
692-76-168	2:42174	*See* N-76-31115
695-76-139	2:42191	*See* N-76-27752
711-76-29	2:41188	*See* N-76-30657
912-76-171	2:42169	*See* N-76-31126

Report No.	*Abstract No.*	*Availability*	*Report No.*	*Abstract No.*	*Availability*
Y/OWI/SUB-76/16503	2:41142	Dep. NTIS, PC A04/MF A01	Y/OWI/TM-22	2:41143	Dep. NTIS, PC A03/MF A01

Abbreviations Used in Availability Column

AT Liquid Metal Fast Breeder Reactor applied technology is available to domestic requesters within the United States from the ERDA Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.
Information regarding subscription purchase will be sent on request.
Foreign requesters should address inquiries to the above address.

Dep. ERDA reports so designated are maintained in the organizations listed on the inside front cover.

EM Inquiries regarding the availability of blueline prints of ERDA engineering drawings which were formerly available for sale by NTIS should be addressed to ERDA Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.

GJO Available from ERDA, Grand Junction Office, P. O. Box 2567, Grand Junction, Colorado 81501.

GPO For sale by the Superintendent of Documents, Government Printing Office, Washington, D. C. 20402.

LMEC Available *only to requesters within the United States* from the Liquid Metal Engineering Center, P. O. Box 1449, Canoga Park, California 91304.

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RSO Available *only to requesters within the United States* from the Reactor Standards Office, Oak Ridge National Laboratory, P. O. Box X, Oak Ridge, Tennessee 37830.

TIC Available from the ERDA Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.

NTIS STANDARD NORTH AMERICAN PRICE CODES

Issue #2

January 1977

Most NTIS products and services are now announced by price codes and, therefore, without specific prices in NTIS journals, newsletters and indexes.

The current dollar equivalent for each code is shown in the schedule below. Orders must list the accession number(s) and be accompanied by the total dollar amount from the current schedule.

Price codes will be published twice a year, in January and July

The prices in this Issue #2 will be valid through June 30, 1977. After June 30, source clients who have not received the latest schedule may contact the Input Branch, 703-557-4690 for the next issue.

NORTH AMERICAN CONTINENT PRICE SCHEDULE

Customers in Canada, U.S., and Mexico please use this price schedule; other addressees write for prices.

A01	$3.00*	E01	$3.25	T01	$97.50
A02	3.50	E02	4.75	T02	100.00
A03	4.00	E03	6.25	T03	150.00
A04	4.50	E04	7.50	T04	200.00
A05	5.00	E05	9.00	T05	250.00
A06	5.50	E06	10.50	T06	300.00
A07	6.00	E07	12.50	T07	350.00
A08	6.75	E08	15.00	T08	400.00
A09	7.50	E09	17.50	T09	450.00
A10	7.75	E10	20.00	T10	500.00
A11	8.00	E11	22.50	T11	550.00
A12	9.00	E12	25.00	T12	600.00
A13	9.25	E13	28.00	T13	650.00
A14	9.75	E14	31.00	T14	700.00
A15	10.00	E15	34.00	T15	750.00
A16	10.50	E16	37.00	T16	800.00
A17	10.75	E17	40.00	T17	850.00
A18	11.00	E18	45.00	T18	900.00
A19	11.75	E19	50.00	T19	950.00
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